What Are the Variables Associated With Altmetric Scores? – An Overview of Methodological Reviews

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Abstract

Background: Currently, social media has been used to disseminate contents of scientific articles. In order to measure this type of impact a new tool named *Altmetric* was created. *Altmetric* aims to quantify the impact of each article through the media online. This overview of methodological reviews aims to describe the associations between the publishing journal and the publishing articles variables with *Altmetric* scores.

Methods: Search strategies on MEDLINE, EMBASE, CINAHL, CENTRAL and Cochrane Library. We extracted data related to the publishing trial and the publishing journal associated with *Altmetric* scores.

Results: A total of 11 studies were considered eligible. These studies summarized a total of 565,352 articles. The variables citation counts, journal impact factor, access counts, papers published as open access and press release generated by the publishing journal were associated with *Altmetric* scores. The magnitudes of these correlations ranged from weak to moderate.

Conclusion: Citation counts and journal impact factor are the most common associators of high *Altmetric* scores. Other variables such as access counts, papers published in open access journals and the use of press releases are also likely to influence online media attention.

Systematic Review registrations: Not applicable

1. Background

The most common way to assess the impact of an article is based upon the number of citations[1]. Moreover, the mean number of citations for all the articles published in the journal in the preceding two years is named journal's impact factor[1]. However, the number of citations and the journal's impact factor do not precisely reflect if the message of the paper is reaching a wider audience[2]. Currently, social media has been used to disseminate contents of scientific articles[3, 4]. However until recently, the impact of scientific articles on social media was not quantified. In order to measure this type of impact a new score (named as *Altmetric*) was created[3, 4].

Altmetric measures the impact of each article through the attention attracted online[3]. Moreover, the *Altmetric* score reveals the instantaneous attention attracted online of the articles in news outlets, commentaries on blogs, number of tweets and mentions on social media. There are two types of *Altmetric* scores. The *Altmetric mentioned* score includes data sources involving social media (e.g. Facebook, Twitter); newspapers, encyclopaedias (e.g. Wikipedia); online platforms (e.g. Faculty1000 and Publication Peer-Reviews); videos on YouTube; sites on questions and answers (e.g. Q&A stack overflow) and policy documents on PDF documents available over the internet. The *Altmetric reader* score includes data sources involving reference managers available online (e.g. Mendeley, CiteULike and Connotea).

Research about *Altmetric* is increasing and becoming more popular in the recent years[5]. However, most articles about *Altmetric* published to date are only introductory tutorials or editorials[1, 3, 4, 6, 7]. Patthi et

al[2] published a systematic review in the field of dentistry that aimed to analyze the correlations between journal citations and *Altmetric* scores. This review concluded that journal citations and *Altmetric* scores are positively correlated (with Pearson's r ranging from 0.30 to 0.61).

Recent articles from several research fields[8–12], showed that the number of citations of articles and *Altmetric* are positively associated. Finch et al.[10] showed that the number of tweets (*i.e. an Altmetric* component) could predict citations within the first 3 days of article publication. Araujo et al.[13] found that number of citations and journal's impact factor were positively associated with *Altmetric*[13]. These authors also found that the number of years since publication and having a descriptive title (title describes the aim, but does not reveal the main conclusions) were negatively associated with *Altmetric*[13]. Therefore, it is assumed that the publishing journal and the publishing articles variables, for example citation counts, journal impact factor, access counts (*i.e. considered as the sum of HTML views and PDF downloads*), papers published as open access, time since publication and press release generated by the publishing journal are likely to be associated with the *Altmetric*[13]. This overview of methodological reviews aims to summarize all available evidence on the associations between the publishing journal and the publishing articles variables with *Altmetric* scores.

2. Methods

2.1 Research Question

What are the publishing journal and the publishing articles variables associated with *Altmetric* scores?

2.2 Search strategy for identification of studies

Systematic searches were conducted on MEDLINE, EMBASE, CINAHL, CENTRAL and Cochrane Library, including publications since the inception of these databases until July 3, 2018 without language restrictions. We used two search terms (*Altmetric* OR *Altmetrics*) in all databases.

2.3 Inclusion criteria

We included any original research article that measured any type of association between the publishing journal and the publishing article with *Altmetric* scores, such as: citation counts (*i.e. number of citations*), journal impact factor, access counts (*i.e. considered as the sum of HTML views and PDF downloads*), papers published as open access, time since publication and press release generated by the publishing journal.

2.4 Exclusion Criteria

Letters to the editor, editorials and conference abstracts were excluded.

2.5 Data collection

Two review authors (AA and AV) independently screened all studies for eligibility and data extraction. All discrepancies identified during the stages and throughout the review were resolved via discussion, or by

arbitration provided by another investigator (DN). The study selection process included: (1) screening the titles and abstracts and (2) screening of full text articles.

2.6 Data extraction

Two review authors independently extracted the following data: (1) authors; (2) year of publication; (3) research field; (4) sample size of articles analysed; (5) study designs of the included articles; (6) aims of the article; (7) study results; (8) study conclusions. Variables about the publishing journal of articles included: (9) journal impact factor; (10) access counts (i.e. considered as the sum of HTML views and PDF downloads); (11) papers published as open access and (12) press release generated by the publishing journal. Variables about the publishing articles included: (13) citation counts (i.e. number of citations) and (14) time since publication. We also collected data related to (15) the *Altmetric mentioned* score and (16) the *Altmetric reader* score. We contacted authors by email to request the any information that was not reported in the original manuscripts.

2.7 Ethics and registration

No ethical approval was required for this type of study. As this review has no clinical outcomes, no registration was needed.

2.8 Data analysis

In this study was not possible to perform a meta-analysis of the studies due to the large heterogeneity. For this reason, our results were reported descriptively.

3. Results

3.1 Search results

The initial electronic database search yielded a total of 334 potentially eligible studies. After screening by title and abstract and removal of duplicates, we considered 22 potentially eligible studies for inclusion and retrieved full-text articles. Eleven published studies[12–22] met the inclusion criteria and were included in this review. The study flow diagram of the eligibility assessment is presented in FIGURE 1.

3.2 Characteristics of included studies

A total of 11 studies were considered eligible. These studies summarized a total of 565,352 articles. Eligible studies were published between 2014 and 2018. The study design of the included articles were mixed research designs[12,14–22] and randomized controlled trials in low back pain[13]. The research fields from these articles include Medical Education[14], Physiotherapy[13], Emergency Medicine[21], Biomedical Area[15], Multidisciplinary[16], Dentistry[22], Social Sciences & Humanities, Engineering & Technology, Medical & Natural Sciences[17], Oncology[18], Solid Organ Transplantation[19], Ecology and Conservation[20] and Radiology[12]. The main objective of the included studies was assessing the association with *Altmetric* scores and the variables: citation counts (i.e. number of citations), journal

impact factor, access counts (i.e. considered as the sum of HTML views and PDF downloads), papers published as open access, time since publication and/or press release generated by the publishing journal. The summary of the methods, data analysis, results and conclusions are presented in the TABLE 1.

3.3 Statistical analysis and associations of included studies

Different types of analyses were performed in the included studies: correlation analysis[12,14,16,19,21,22], multivariable regression analysis[13,18], boosted regression trees analysis[20], principal component analysis and factor analysis[15,17]. The main results of the included studies demonstrated that the variables citation counts (i.e. number of citations), journal impact factor, access counts (i.e. considered as the sum of HTML views and PDF downloads), papers published as open access, time since publication and press release generated by the publishing journal were associated with *Altmetric* scores. The magnitude of these associations ranged from weak to moderate (TABLE 2).

4. Discussion

The objective of this overview of methodological reviews was to summarize all available evidence on the associations between the publishing journal and the publishing articles variables with *Altmetric* scores. We found that citation counts (i.e. number of citations), journal impact factor, access counts (i.e. considered as the sum of HTML views and PDF downloads), papers published as open access, time since publication and press release generated by the publishing journal were associated with *Altmetric* scores. The magnitude of these associations ranged from weak to moderate. Besides that, we observed that citation counts or journal impact factor were associated with *Altmetric* scores in all included studies[12–22].

There is a previous systematic review about the correlation between citations counts and *Altmetric* in medical research[2]. Besides that, there are articles that have measured associations between the citation counts and *Altmetric* scores[12, 14]. According with the systematic review[2] and these articles[12, 14] there is a positive correlation between citation counts and *Altmetric* scores. Similarly, our overview found positive associations (ranged from weak to moderate) between citation counts and *Altmetric* scores[12–22]. These results are similar to the ones related to journal's impact factor[13]. This is no unexpected, since the journal's impact factor is based on citations counts of scientific articles[1].

We also found that most included articles, with the exception of Araujo et al[13] and Knight[19], did not analyze the *Altmetric reader* score. In this way, our findings are largely are based on *Altmetric mentioned* score. We strongly recommend that further investigations on *Altmetric reader* score should be conducted.

There are no studies that have identified specific characteristics of articles, for example, analysis on studies that published popular/hot topics (e.g. studies on zika virus, miraculous diets, cancer prevention, early life in earth, religious evidence). Moreover, there are no analysis of studies comparing if the direction

of the results (i.e. positive versus negative conclusions) influences Altmetric scores. These characteristics are likely to increase the number of access and sharing these articles on social media[13]. We recommend that future studies should identify if these characteristics are associated with *Altmetric* scores.

The major strength of this study is about the inclusion of studies from all fields of the research (n = 565,352 articles analysed). On the other hand, a possible limitation of this study is about the large heterogeneity of the included studies. Because of this, the data was analysed only descriptively. The *Altmetric* is still a new topic and there are just few available studies.

5. Conclusion

Citation counts, journal impact factor, access counts (i.e. considered as the sum of HTML views and PDF downloads), papers published as open access, time since publication and press release generated by the publishing journal were associated with *Altmetric* scores. However, more research is needed to confirm the results obtained in this overview of methodological reviews.

List Of Abbreviations

Not applicable.

Declarations

Ethical Approval and Consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

A.A, A.V collected the data and performed the analysis. L.C supervised the project. A.A, A.V, D.N, G.Z and L.C wrote the manuscript.

Acklowdgements

Not applicable.

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Tables

TABLE 1. Summary of the studies

No	Author and year of publication (research field)	Objectives	Methods and data analysis	Results	Author's Conclusions
1	Amath et al., 2017 [14] (Medical Education Journals)	"...to characterize the relationships among <i>Altmetric</i> score, access counts, citations... and to clarify the roles of these metrics in assessing the impact of medical education academic scholarship."	All papers published in Medical Education Journal between 2012 and 2013 were retrieved (n=482). Authors extracted data related to citation counts, access counts and <i>Altmetric</i> score. Descriptive statistics and pearson correlations (r-values) between metrics of interest were performed.	The correlation between access counts (r=0.30) and citation counts (r=0.25) demonstrated weak correlation with <i>Altmetric</i> score.	<i>Altmetric</i> scores were weakly correlated with readership (access counts) and impact (citation counts).
2	Araujo et al., 2018 [13] (Physiotherapy)	"...to analyze potential factors related with the publishing journal and the publishing trial that could be associated with <i>Altmetric</i> score..."	A total of 200 clinical trials in the field of physiotherapy interventions for back pain, published between 2010 and 2015 were included. Authors extracted data related to the citation counts, journal impact factor, time since publication and <i>Altmetric</i> score. Descriptive statistics and multivariate regression	A total of four variables were associated with <i>Altmetric</i> mentioned score: journal impact factor ($\beta=3.4$ points), number of citations divided by years since publication ($\beta=5.2$ points) and number of years since publication ($\beta=-4.9$ points) Only one independent variable was associated with <i>Altmetric</i>	"Researchers should preferably select high impact factor journals for submission... these factors are likely to increase the visibility of their studies in social media."

			models were performed.	reader score: number of citations divided by years since publication ($\beta=10.1$ points).	
3	Barbic et al., 2016[21] (Emergency Medicine)	<p>"... to describe the traditional metrics and <i>Altmetric</i> scores of the 50 most frequently cited articles published in emergency medicine (EM) journals. Since many articles related to EM are published in other journals, the secondary aim of this study was to describe the <i>Altmetric</i> scores of the most frequently cited articles relevant to EM in other biomedical journals."</p>	<p>The most frequently cited articles in the top 10 Emergency Medicine journals were included. In total 50 papers were included. Authors extracted on citation counts, journal impact factor and <i>Altmetric</i> score.</p> <p>Descriptive statistics and spearman correlations (r-values) were performed.</p>	<p>Authors observed a correlation between citation counts ($r=0.22$) and journal impact factor ($r=0.35$) with <i>Altmetric</i> score.</p>	<p>The study demonstrated that there is weak correlation between citation counts and journal impact factor with <i>Altmetric</i> scores for the top papers in Emergency Medicine and other biomedical journals.</p>
4	Bornmann et al., 2018[15] (Biomedical Area)	<p>"...to analyze the dimensions of measurement for traditional metrics (citation counts) and <i>Altmetric</i> by using principal component analysis (PCA) and factor analysis (FA)..."</p>	<p>A search in F1000Prime and <i>Altmetric</i> dataset between 2011 and 2013 was conducted. In total 33.683 papers were included. Authors extracted data on citation counts and <i>Altmetric</i> score.</p> <p>Principal component analysis (PCA), factor analysis</p>	<p>"...the results of the PCA and FA showed that <i>Altmetric</i> score operate along different dimensions, whereas Mendeley counts are related to citation counts..."</p>	<p><i>Altmetric</i> reader score are associated to citation counts.</p>

(FA) and regression models were performed.

5	Costas et al., 2015 [16] (Multidisciplinary)	To determine the relationship between citation counts, journal impact factor and <i>Altmetric</i> score.	In total 500.229 papers were included. Authors extracted data on citation counts, journal impact factor and <i>Altmetric</i> score. Descriptive statistics and spearman correlations (r-values) were performed.	Authors observed a correlation between citation counts (r=0.18) and journal impact factor (r=0.19) with <i>Altmetric</i> score.	"...the weak correlation with citations suggests that the potential of <i>Altmetric</i> to replace traditional citation analysis is not very strong..."
6	Delli et al., 2017 [22] (Dentistry)	"To identify the most discussed dental articles on the Web and to assess the association between <i>Altmetric</i> score, publication characteristics and citations."	A search in <i>Altmetric</i> dataset for articles published in the 91 dental journals in 2015 was performed. In total 100 articles with the highest online attention dental journals were included. Authors extracted data on citation counts, time since publication and <i>Altmetric</i> score. Descriptive statistics, Kruskal-Wallis test and spearman correlations (r-	The correlation between days since publication of articles (r=-0.25) with <i>Altmetric</i> score demonstrated negative and weak correlation. The correlation between citations counts (r=0.27) demonstrated positive and weak correlation with <i>Altmetric</i> score.	"Increased social impact of dental articles is not significantly associated with high citation rates."

values) were performed.

7	<p>Didegah et al., 2018[17]</p> <p>(Social Sciences & Humanities, Engineering & Technology, Medical & Natural Sciences)</p>	<p>To analyze the differences between citation counts and <i>Altmetric</i> factors.</p>	<p>All papers indexed by the Web of Science by selecting Finland as the country and publishing years between 2012 and 2014 were performed. In total 13.623 papers were included. Authors extracted data on citation counts and <i>Altmetric</i> score.</p>	<p>"...journal impact factor... are the two factors that significantly associate with increased citation counts and with all <i>Altmetric</i> scores."</p>	<p><i>Altmetric</i> reader score are associated to citation counts.</p>
			<p>Factor analysis was performed.</p>		
8	<p>Haneef et al., 2017[18]</p> <p>(Oncology)</p>	<p>"...to describe and identify the factors associated with online media attention of articles evaluating cancer treatments."</p>	<p>The search in PubMed published during the first 6 months of 2014 in oncology and medical journals was performed. In total 792 papers were included. Authors extracted data on journal impact factor, press release, open access and <i>Altmetric</i> score.</p>	<p>Factors associated with high <i>Altmetric</i> score were presence of a press release (RoM=10.14, 95% CI [4.91–20.96]), open access articles (RoM=1.48, 95%CI [1.02–2.16]), and journal impact factor (RoM=1.10, 95%CI [1.07–1.12].</p>	<p>"Most important factors associated with high online media attention were the presence of a press release and the journal impact factor..."</p>
			<p>Descriptive statistics, regression analysis and regression</p>		

coefficients represent the logarithm of ratio of mean (RoM) were performed.

9	Knight, 2014 [19] (Solid Organ Transplantation)	"...to measure the current use of alternative metrics... and to examine the association between <i>Altmetric</i> score and traditional citation measures in the field of solid organ transplantation."	The search in MEDLINE with subject headings relating to solid organ transplantation between August 2011 and July 2012 was performed. In total 6.979 articles were included. Authors extracted data on citation counts and <i>Altmetric</i> score.	The correlation between citation counts ($r=0.16$) with <i>Altmetric</i> mentioned score demonstrated weak correlation. The correlation between citation counts ($r=0.23$) with <i>Altmetric</i> reader score demonstrated weak correlation.	"Social media and online attention act as early predictors of the impact of transplant research as measured by later citation rate. Blogging and expert recommendation, in particular, are associated with higher citation rates."
			Descriptive statistics, Wilcoxon Rank-sum test and spearman correlations (r -values) were performed.		
10	Lamb et al., 2018 [20] (Ecology and Conservation)	"...to measure the association between citation rates and the <i>Altmetric</i> score - an indicator of the amount and reach of the attention an article has received - along with other forms of bibliometric performance..."	A search in SCOPUS with subject headings relating to ecology and conservation between 2005 and 2015 was performed. In total 8.322 papers were included. The data extracted were citation counts and <i>Altmetric</i> score.	The results demonstrate that <i>Altmetric</i> score was positively correlated with citation counts.	Authors found strong association between science communication (measured by the <i>Altmetric</i> score) and citation counts.

			Boosted regression trees were performed.		
11	Rosenkrantz et al., 2017[12] (Radiology)	"...to compare traditional citation and alternative impact metrics (<i>Altmetric</i> score) for articles in popular general radiology journals."	The search in 2013 journals of radiology was performed. In total 892 papers were included. Authors extracted data on citation counts and <i>Altmetric</i> score.	The correlation between citation counts ($r=0.20$) was weakly correlated with <i>Altmetric</i> score.	"In conclusion, articles published in four popular radiology journals overall received relatively low attention on social media and other online platforms in comparison with citations..."
			Descriptive statistics, the McNemar test, the Mann-Whitney test and the pearson correlation.		

TABLE 2. Summary of the association between variables of the publishing journal and the publishing articles with *Altmetric* scores

Studies and analyses	Citation counts	Journal impact factor	Access counts	Open access	Time since publication	Press release
Correlation analysis						
Amath et al., 2017[14]	r=0.25		r=0.30			
Barbic et al., 2016[21]	r=0.22	r=0.35				
Costas et al., 2015[16]	r=0.18	r=0.19				
Delli et al., 2017[22]	r=0.27				r=-0.25	
Knight, 2014[19]	r=0.16* and r=0.23**					
Rosenkrantz et al., 2017[12]	r=0.20					
Multivariate regression analysis						
Araujo et al., 2018[13]	$\beta=5.2^*$ and $\beta=10.1^{**}$	$\beta=3.4$			$\beta=-4.9$	
Haneef et al., 2017[18]		RoM=1.10		RoM=1.48		RoM=10.14
Boosted regression trees analysis						
Lamb et al., 2018[20] <i>Altmetric</i> scores was strongly associated with citation counts.						
Principal component analysis and factor analysis						
Bornmann et al., 2018[15] <i>Altmetric reader</i> score are associated to citation counts.						
Didegah et al., 2018[17] <i>Altmetric reader</i> score are associated to citation counts.						

*These numbers represent *Altmetric mentioned*. **These numbers represent *Altmetric reader*. r= Correlation estimates. RoM= Regression coefficients represent the logarithm of ratio of mean. β = β coefficient.

Figures

Figure 1

Study flow diagram of the eligibility assessment.

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