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Does the quality of orthodontic studies influence their Altmetric Attention Score?

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Objective: The aim of this study was to determine whether an association between study quality, other study characteristics, and Altmetric Attention Scores (AASs) existed in orthodontic studies. **Methods:** The Scopus database was searched to identify orthodontic studies published between January 1, 2017, and December 31, 2019. Articles that satisfied the eligibility criteria were included in this study. Study characteristics, including study quality were extracted and entered into a pre-pilot data collection sheet. Descriptive statistics were calculated. On an exploratory basis, random forest and gradient boosting machine learning algorithms were used to examine the influence of article characteristics on AAS. **Results:** In total, 586 studies with an AAS were analyzed. Overall, the mean AAS of the samples was 5. Twitter was the most popular social media platform for publicizing studies, accounting for 53.7%. In terms of study quality, only 19.1% of the studies were rated as having a high level of quality, with 41.8% of the studies deemed moderate quality. The type of social media platform, number of citations, impact factor, and study type were among the most influential characteristics of AAS in both models. In contrast, study quality was one of the least influential characteristics on the AAS. **Conclusions:** Social media platforms contributed the most to the AAS for orthodontic studies, whereas study quality had little impact on the AAS.

Key words: Altmetric Attention Score, Social media

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INTRODUCTION

The impact factor is a citation metric that has been used to measure the impact of scientific journals in a specific field.[1] Additionally, the contributions and performance of researchers, universities, departments, and research groups are evaluated using citation counts, which has also become a key factor analysed before awarding research grants.[2] Despite the widespread use of citation metrics, such approach is flawed due to factors such as the lack of consideration of the reasons for the citation of an article, manipulation of citation patterns, and underestimation of the impact of recently published articles because of the delay between the publication of the study and its first citation and indexing in a citation database.[2-4]

Social media platforms have revolutionized the dissemination of studies' findings, allowing researchers to explore new approaches to publication accessibility for stakeholders and policymakers.[2,4,5] Altmetric was introduced in 2010 and has been employed to measure the attention or social impact that publications attract on the social web.[6] Altmetric Attention Score (AAS) (Altmetric LLP, London, UK) have been proposed to overcome the shortcomings of traditional journal citation metrics by facilitating publication updating in real time and providing a broader portrait of the influence of an article.[7,8] The AAS is a weighted count of all the sources of online attention that a research article or researcher may receive. The sources that contribute to the AAS are public policy documents, blogs, mainstream media, citations, online reference managers, research highlights, post-publication peer-review platforms, social media, Wikipedia, Open Syllabus Project, patents, multimedia, and other online platforms (Altmetric LLP). Their increasing relevance is highlighted by several publishers of academic journals, including Elsevier, Oxford University Press, Springer, and Wiley, having recognized their use as a measure of impact.[8] Furthermore, Altmetrics are being used by research funding bodies as an alternative to traditional citation metrics to assess research use.[9] Articles with a higher AAS seem to correlate with a higher social impact.[10,11] Social media platforms such as Twitter have been utilized to disseminate the findings of orthodontic-related studies.[12,13] However, such platforms appear to be under-utilized, and improvements in accessibility for both scholars and non-scholars are required.[14] Factors related to social media platforms like journal accounts[5] and posts[15] can influence whether an article will be shared on social media.

Despite its advantages, the AAS weighting surprisingly does not consider the quality of each study. The practice of evidence-based dentistry is advocated and strengthened by the use of high-quality studies to inform healthcare decisions.[16] Study quality involves the assessment of the risk of bias (RoB), with various tools available for the evaluation of different study types. Both citation rates and journal impact factor have been associated with AASs.[17] However, citation counts do not necessarily correlate with study quality.[18] Therefore, the aim of this study was to determine whether an association between orthodontic study characteristics and their AAS exists; the null hypothesis was that study quality had no influence on the AAS.

MATERIALS AND METHODS

Eligibility criteria

Orthodontic studies with an AAS published between January 1, 2017, and December 31, 2019, were identified. Studies published in non-English languages, before January 2017 or after December 2019, as well as those unrelated to orthodontics were excluded.

Search and selection of studies

A search of the Scopus database (www.scopus.com) using the term "orthodontics" was undertaken by 1 author (TA) on July 9, 2020. The following search filters were applied: publication date (January 1, 2017, to December 31, 2019), language (English only), and journal title. The database search was performed on two occasions, four weeks apart, to evaluate changes in both the number of article citations and AAS; if a change was identified, the average score was recorded. All titles and abstracts were screened by the same author (TA) on both occasions.

Data extraction

All study characteristics were extracted by a single author (TA) and entered into a pre-piloted Microsoft Excel® (Microsoft, Redmond, WA, USA) data collection sheet. A second author (JS) cross-checked all variables from the extracted data independently to ensure the consistency of the data collected. The following characteristics were extracted from each study: year of publication, country of correspondence of the author (categorized as Europe, America, Asia, and rest of the world), journal title (categorized as American Journal of Orthodontics and Dentofacial Orthopaedics [AJODO], Australian Orthodontic Journal [AOJ], Journal of Orthodontics [JO], European Journal of Orthodontics [EJO], Journal of Clinical orthodontics [JCO], Journal of Orofacial Orthopaedics [JOO], Angle Orthodontist [AO], Orthodontics and Craniofacial Research [OCR], and other orthodontic journals), number of authors, study classification (appliances, diagnostic studies, materials, devices for patient use, software, pharmaceutical and others –including scanner, radiographic equipment, dental unit, curing light, laser

system, and whitening systems), number of citations (reported citation counts obtained from [www.scopus.com]), AAS (Bookmarklet tool [www.almetrics.com]), social media platform that the article was shared on (categorized as Facebook, Twitter, Mendeley, Facebook and Twitter, or Multiple platforms [www.altmetric.com]), and impact factor (as reported by the Scimago Journal Rank). The quality of each article was assessed using a previously validated and predetermined set of criteria and graded accordingly (Table 1).[19]

Statistical analysis

Descriptive statistics were calculated for all study characteristics. To identify the influence of article predicator characteristics on the AAS, two machine learning algorithms were implemented: the random forest (randomForest package) and the gradient boosting machine approach (gbm package) in the R statistical software. The random forest[20] model employs bootstrapping to create multiple copies of the original training dataset, fits a separate decision tree to each copy, and then combines all results to create a single predictive model. Gradient boosting[21] operates similarly, however, trees are grown sequentially, and each tree is grown using information from previously grown trees. In all algorithms, Poisson regression was selected and was in agreement with the count nature of the dependent variable. All analyses were performed using Stata 16.1 (Stata Corp., College Station, TX, USA) and R Software version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Criteria total of 586 eligible studies were identified (Figure 1). A 100% agreement was achieved between the two authors (TA and JS) for all the collected study characteristics. Within this sample, most studies with an AAS were published in 2018 (34.3%), with corresponding authors primarily based in Europe (41.5%). Studies classified as "others" (scanner, dental unit, radiographic equipment, curing light, whitening system, and laser system) most commonly possessed an AAS (58.0%). Twitter was the most popular social media platform to publicize the studies (53.7%). The most common study type was cross-sectional (23.2%). In terms of study quality, only 19.1% of the studies were rated as having a high level of quality, with 41.8% deemed as moderate quality. The mean number of authors was 4.5, and the mean journal impact factor and number of citations were 0.83 and 4.7, respectively (Table 2).

Overall, the mean AAS of the samples was 5 and the average AAS per study characteristics is presented in Table 3. A higher mean AAS was evident for the following characteristics: articles published in 2017; articles published in Orthodontics and Craniofacial Research; articles with authors based in the Americas; studies classified as pharmaceutical; cohort-type studies; and studies rated as high quality.

To fit the machine learning algorithms, two outlier observations (namely, 396 and 140) were deleted because the results were unreliable. The randomForest approach ranked ten predictors associated with the AAS, and the variance explained was 42.5%, suggesting that other important unmeasured Altmetric parameters exist (Figure 2). Table 4 shows the ranking (1, highest influence; 10, lowest influence) of the predictors based on the two approaches implemented. The type of social media platform, number of citations, impact factor, and study type were among the most influential characteristics of AAS in both models. In contrast, study quality was one of the least influential characteristics of the AAS.

Table 1. Predetermined criteria used to assess study quality

Grade	Criteria
A (high value of evidence)	All criteria should be met: • Randomized clinical study or a prospective study with a well-defined control group • Defined diagnosis and endpoints • Diagnostic reliability tests and reproducibility tests described • Blinded outcome assessment
B (moderate value of evidence)	All criteria should be met: • Cohort study or retrospective case series with defined control or reference group • Defined diagnosis and endpoints • Diagnostic reliability tests and reproducibility tests described
C (low value of evidence)	One or more of the conditions below: • Large attrition • Unclear diagnosis and endpoints • Poorly defined patient material

Adapted from the article of Bondemark et al. (Angle Orthod 2007;77:181-91).[19]

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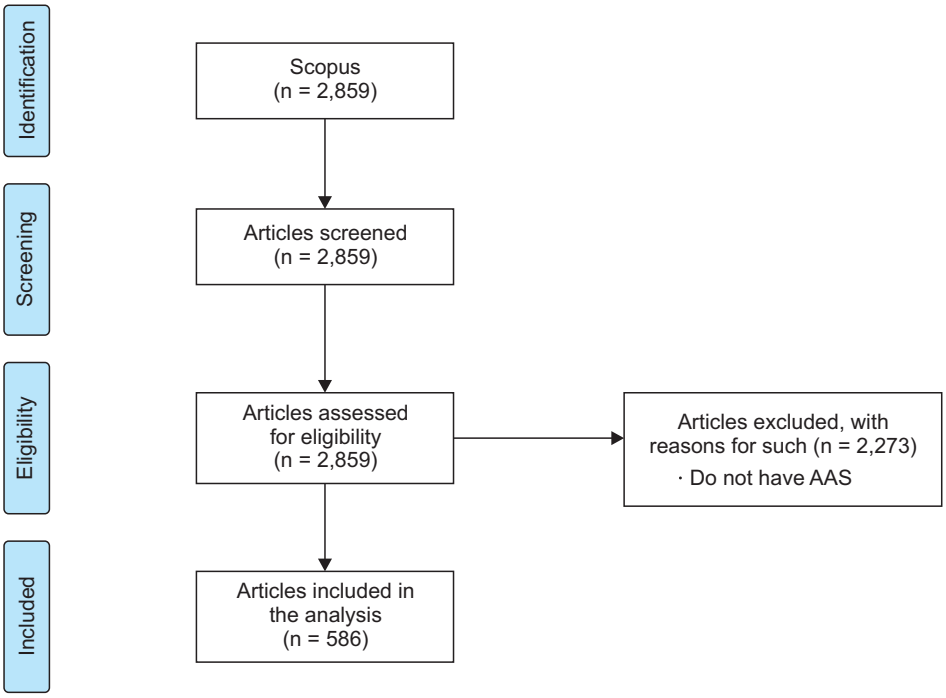

Figure 1. Flow diagram for the identification and selection of articles with an AAS. AAS, Altmetric Attention Score.

DISCUSSION

AAS measures the amount of attention a study receives and is calculated using an automated algorithm that examines different sources in real time. Each source is weighted based on its relative impact. For example, if a study was mentioned in the news, this would be weighted more than a mention on Twitter or online reference managers. Based on this, the findings of the current study show that the greatest influence on AAS in orthodontic studies is the amount of attention received from social media platforms.

When comparing social media platforms, Twitter was the most commonly used social media platform in this study cohort (Table 1), which is similar to the findings of a previous report.[5] Tweets are regarded as an effective method for sharing dental literature.[22] However, Mendeley has also been reported as a popular social media platform to disseminate information to the community, and online attention to studies in terms of article access and citation counts has been correlated with downloads on Mendeley.[13] The increased influence of social media platforms could also be a manifestation of publishers of orthodontic journals endorsing AAS as a measure of impact.[8] Additionally, journals that possess social media accounts tend to have significant online attention compared to those without social media presence.[23,24]

The online attention of articles can include the number of times an article is accessed or downloaded, uploaded, discussed, bookmarked, cited, and recommended.[25] In the current study, the number of citations and journal impact factors also strongly influenced the AAS for orthodontic studies; such finding is supported by the literature. In a systematic review of the associations between journal and article variables and AAS, both citation counts and journal impact factors were commonly associated with AAS.[17] The accessibility and number of times an article was downloaded were beyond the scope of this study. However, free-access journals that facilitate access and downloading of articles tend to have higher online attention compared to subscription-based journals.[23,26]

Traditional metrics, such as the impact factor of a journal, do not necessarily correlate with the publication of high-level evidence within that journal.[27] Within the current sample, approximately 19% of the studies were classified as having a high level of quality. Interestingly, the quality of the study was one of the characteristics that influenced AAS the least. This appears to conflict with the findings of a previous study, in which a high AAS of randomized clinical trials published in the field of total joint arthroplasty correlated with a high methodological quality.[18] However, such study included a small sample of forty-two trials published in a single year, and potential biases during the assessment of methodological quality were not accounted for; notably, despite their reported findings, the authors concluded that clinicians should still critically evaluate studies before altering their clinical practice.[18] AAS associated with orthodontic studies apparently cannot be considered a proxy for study quality.

In the current study, 586 studies which had an AAS

Table 2. Characteristics of articles with Altmetric Attention Scores

Article characteristics	n = 586
Year of publication	
2017	212 (36.2)
2018	201 (34.3)
2019	173 (29.5)
Journal title	
AJODO	55 (9.5)
JO	17 (2.9)
EJO	32 (5.5)
JOO	2 (0.3)
AO	20 (3.4)
OCR	16 (2.7)
Other	443 (75.7)
Continent of corresponding author	
Europe	243 (41.5)
Americas	189 (32.3)
Asia and rest of the world	154 (26.2)
Study classification	
Erratum	1 (0.2)
Appliances	95 (16.2)
Diagnostic studies	45 (7.7)
Materials	74 (12.6)
Device for patient use	6 (1.0)
Software	15 (2.6)
Pharmaceutical	10 (1.7)
Other*	340 (58.0)
Study type	
Erratum	1 (0.2)
Systematic review	49 (8.4)
Systematic review with meta-analysis	41 (7.0)
Randomized clinical trial	26 (4.4)
Case-control	20 (3.4)
Cohort	80 (13.7)
Cross-sectional study	136 (23.2)
Case series	8 (1.4)
Case report	44 (7.5)
Opinion (editorials/letters/notes)	59 (10.1)
Narrative review	74 (12.6)
In-vitro	41 (7.0)
Qualitative	7 (1.1)
Study quality	
High	112 (19.1)
Moderate	245 (41.8)
Low	229 (39.1)
Type of social media platform	
Not shared	40 (6.8)
Twitter	315 (53.7)
Facebook and Twitter	97 (16.6)
Multiple	134 (22.9)
AAS	
Mean	5
Median (IQR)	1 (3)
Impact factor	
Mean	0.83
Median (IQR)	0.78 (0.65)
Number of citations	
Mean	4.7
Median (IQR)	2 (5)
Number of authors	
Mean	4.5
Median (IQR)	4 (3)

Values are presented as number (%).
AJODO, American Journal of Orthodontics and Dentofacial Orthopaedics; JO, Journal of Orthodontics; EJO, European Journal of Orthodontics; JOO, Journal of Orofacial Orthopaedics; AO, Angle Orthodontist; OCR, Orthodontics and Craniofacial Research; AAS, Altmetric Attention Score; IQR, interquartile range.
*Scanner, dental unit, radiographic equipment, curing light, whitening system, and laser system.

were identified. As a study of this nature had not been previously conducted, ours represents a large sample size to explore the relationship between study quality and AAS. However, as solely a single database was searched (i.e., Scopus), language restrictions applied, and the broad search term "orthodontics" was used, we may have underestimated the true number of orthodontic studies possessing an AAS and, hence, the generalizability of the results may be limited. An assessment of study quality involves an assessment of the RoB in primary studies. We used a tool employed in a previously published systematic review. As described by the authors, this tool assesses both external and internal validity, the quality of the study methodology, and the statistical analysis performed.[19] The study quality domains assessed in this tool are described in Table 1. The selected

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Table 3. The Altimetric Attention Score per study characteristics (n = 586)

Study characteristics	Mean	Median	IQR
Year of publication			
2017	6.4	1	3
2018	4.2	1	3
2019	4.3	1	2
Journal title			
AJODO	3.1	1	3
JO	2.5	1	4
EJO	4.5	4.5	7
JOO	4	4	6
AO	3.7	2	4
OCR	5.8	1	4
Other	5.4	1	2
Continent of corresponding author			
Europe	5.2	1	4
Americas	5.7	1	2
Asia and rest of the world	3.9	1	2
Study classification			
Erratum	1	1	0
Appliances	5.1	1	4
Diagnostic studies	4.3	1	4
Materials	3.4	1	1
Device for patient use	3.5	2	5
Software	2.6	1	1
Pharmaceutical	7.2	2	4
Other*	5.5	1	3
Study type			
Erratum	1	1	0
Systematic review	7.7	2	6
Systematic review with meta-analysis	6.1	5	7
Randomized clinical trial	3.2	1	4
Case-control	3.3	2	4
Cohort	9.6	1	3
Cross-sectional study	3.5	1	2
Case series	1	1	0
Case report	2.4	1	1
Opinion (editorials/letters/notes)	3.7	1	2
Narrative review	4.4	1.5	3
In-vitro	5.5	1	1
Qualitative	3.6	3	4
Study quality			
High	6.1	2	7
Moderate	5.5	1	2
Low	4	1	2
Type of social media platform			
Not shared	1	1	0
Twitter	1.6	1	0
Facebook and Twitter	3.4	2	2
Multiple	15	8	8

AJODO, American Journal of Orthodontics and Dentofacial Orthopaedics; JO, Journal of Orthodontics; EJO, European Journal of Orthodontics; JOO, Journal of Orofacial Orthopaedics; AO, Angle Orthodontist; OCR, Orthodontics and Craniofacial Research; IQR, interquartile range.
*Scanner, dental unit, radiographic equipment, curing light, whitening system, and laser system.

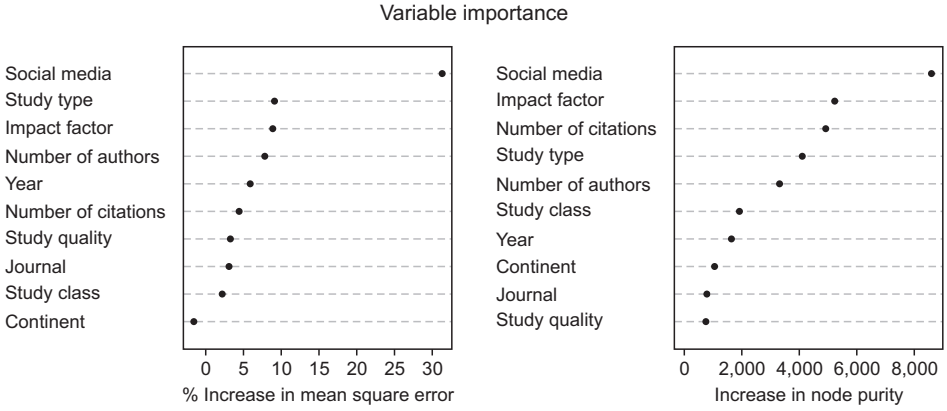

Figure 2. Percentage decrease in accuracy by elimination of the ten predictors, one at a time, using random forest (n = 584).

Table 4. Ranking of the predictors based on the two machine learning algorithms (randomForest and gradient boosting machine), in which 1 represents the highest and 10 the lowest influence

Predictor	Random forest	GBM (relative influence)
Social media platform	1	1 (42.5)
Study type	2	4 (6.3)
Impact factor	3	3 (18.8)
Number of authors	4	5 (5.6)
Year of publication	5	6 (1.4)
Number of citations	6	2 (23.3)
Study quality	7	10 (0.02)
Journal	8	8 (0.78)
Study classification	9	7 (0.89)
Continent corresponding author	10	9 (0.30)

GBM, gradient boosting machine.

studies were classified into three broad categories. We acknowledge that to gauge a more detailed assessment of study quality, the use of specific RoB tools could be considered. Therefore, the results of this study should be interpreted with caution. Individual assessment of the 586 included studies using specific RoB tools was beyond the scope of this study, yet could be considered in a future study. Furthermore, the number of potential articles could have been increased by screening individual journal websites or by conducting a search via Medline via PubMed. The aim of the current study was not to precisely estimate the effect and precision of each predictor on ASS, but rather to provide initial insights into the AAS determinants, which can also be considered to answer other relevant questions. Articles were selected, and data extraction was primarily performed by a single author. However, to reduce possible biases, all articles included in the final analysis were independently cross-checked by a second author with complete agreement to ensure consistency.

CONCLUSIONS

In this exploratory cross-sectional study, social media platforms had the greatest influence on AASs in orthodontic studies. Among the study characteristics, the study quality had little impact on the AAS of orthodontic studies. Therefore, clinicians should critically evaluate the findings of these studies before implementing them in clinical practice.

AUTHOR CONTRIBUTIONS

Conceptualization: JS, NP. Data curation: TA, JS. Formal analysis: JS, NP. Investigation: TA, JS, NP. Methodology: JS, NP. Supervision: JS, NP, MTC. Writing–original draft: JS, TA NP, MTC. Writing–review & editing: JS, TA NP, MTC.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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