



# The 100 Most Impactful Articles on Total Shoulder Arthroplasty: An Altmetric Analysis

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**Background:** To use the top 100 articles pertaining to total shoulder arthroplasty (TSA) to understand the impact that social media platforms have on the dissemination of shoulder research while highlighting bibliometric factors associated with Altmetric Attention Score (AAS) to offer insight into the impact that social media platforms have on the dissemination, attention, and citation of shoulder research publications.

**Methods:** In June 2023, the Altmetric database was searched using the following PubMed MeSH terms: “total shoulder arthroplasty” or “TSA.” Articles with the highest AAS were screened to exclude other topics unrelated to TSA. The top 100 articles that met inclusion criteria were used in the final analysis. Bibliometric factors pertaining to each study were collected for further analysis of article characteristics in accordance with prior studies.

**Results:** The Altmetric Database query yielded 1,283 studies. After applying our inclusion criteria, the top 118 articles with the highest AAS were identified. The mean AAS was  $29.14 \pm 42.35$ , with a range of 13 to 402. The included articles represented 27 journals, with 70 articles attributed to 2 journals: *Journal of Shoulder and Elbow Surgery* (JSES; 43%) and the *Journal of Bone and Joint Surgery* (JBJS; 16%). There was a significant increase in AAS for the presence of a conflict of interest ( $p = 0.042$ ) and open access status ( $p < 0.01$ ), but no association between the score and citation rate ( $p > 0.05$ ).

**Conclusions:** Top articles on TSA, as defined by high AAS, mostly comprise original clinical research performed in the United States or Europe. The presence of a conflict of interest and open access status is associated with an increase in AAS, but there was no association between AAS score and citation rate.

**Keywords:** *Altmetric, Shoulder arthroplasty, Social media, Total shoulder arthroplasty*

Traditional evaluations of the impact of research is based on author-level bibliometrics such as the Hirsch index (h-index) as well as journal-level metrics such as impact factor (IF).<sup>1,2)</sup> These measures are utilized to quantify research productivity, determine grant funding, and climb academic standings.<sup>3,4)</sup> However, recent works have questioned the

generalizability of such measures, which commonly limit their focus on citation rates within the scientific community while failing to consider the impact of research through nontraditional channels; this includes the increase in open-access journals and social media dissemination of research.<sup>5,6)</sup> As such, researchers and readers are unable to fully understand the influence of a publication using simple bibliometrics. To better ascertain the online impact of an article, the Altmetric Attention Score (AAS) was created using a weighted algorithm based on the amount of social media attention of a given research work.<sup>7,8)</sup> The score tabulates the attention of research publications on sources such as X (Twitter), Facebook, and LinkedIn and weighs each with differing importance in the AAS. Previ-

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ous work has validated the score throughout the medical literature and has demonstrated a positive correlation with citation rates, particularly in orthopedic works.<sup>9-11)</sup>

The AAS has been utilized to identify the most impactful articles in shoulder and elbow surgery, including the rotator cuff and the medial ulnar collateral ligament.<sup>12,13)</sup> However, no prior studies have utilized AAS to evaluate the social media attention garnered by articles pertaining to shoulder arthroplasty. As such, the purpose of the current article was to use the top 100 articles pertaining to shoulder arthroplasty to understand the impact that social media platforms have on the dissemination of total shoulder arthroplasty (TSA) research while highlighting bibliometric factors associated with AAS to offer insight into the impact that social media platforms have on the dissemination, attention, and citation of shoulder research publications.

## METHODS

### Article Selection Criteria

On June 16, 2023, the Altmetric Explorer database (Digital Science, Holtzbrinck Publishing) was searched for articles pertaining to TSA. The PubMed MeSH term “total shoulder arthroplasty” OR “TSA” was entered into the Altmetric Explorer. After stratification by descending AAS, title and abstract review was performed with articles unrelated or not focused on the TSA procedure excluded. The 100 articles pertaining to TSA with the highest AAS scores were included for analysis. The overall AAS score, calculated and updated in real-time, is determined by averaging relatively weighted social media activity scores that an article receives as well as the number of cumulative citations an article receives (Table 1). The AAS includes activity from multiple online platforms, including Facebook, Twitter, and LinkedIn. There is no limit to the AAS an article receives as a study can continue to accumulate mentions over time. Articles that have received no online attention or mentions obtain an AAS of 0. All Altmetric variables from Table 1 were considered in the analysis.

Secondary bibliometric factors pertaining to each study were collected in accordance with prior studies.<sup>10-14)</sup> These article characteristics included journal, article title, date of publication, highest degree obtained by the first author, number of authors, number of academic institutions, geographic region of origin of the publication, open access status of the publication, disclosure of any conflict of interest (presence or absence of general self-reported conflict of interest), study design, subject of study (anatomic TSA, reverse TSA, or other), and the number of referenced studies. Similar to prior Altmetric investigations, study design

was classified as either original clinical research (prospective/retrospective cohort, case-control, case series/report, or randomized controlled trial), systematic review or meta-analysis, review articles, basic science or biomechanics, or other. The institutional affiliation of the corresponding author was utilized to identify the geographic origin of the article from either the United States, Europe, or other.

### Statistical Analysis

All statistical analyses were performed with Stata version 16.1 (StataCorp.). Normality was verified with the Shapiro-Wilks test and was not achieved for any of the included variables. Bibliometric and Altmetric characteristics were summarized by descriptive statistics using means with standard deviations for continuous variables and frequencies with percentages for categorical variables. A multivariable linear regression analysis was conducted to determine

**Table 1.** Altmetric Attention Score Calculation

Social media outlet	Weight
News	8.0
Blog	5.0
Policy document	3.0
Patent	3.0
Wikipedia	3.0
X (Twitter)	1.0
Peer review (Publon, PubPeer)	1.0
Google+*	1.0
F1000	1.0
Weibo <sup>†</sup>	1.0
Syllabi (Open Syllabus)	1.0
LinkedIn	0.5
Reddit	0.25
Facebook	0.25
YouTube	0.25
Pinterest	0.25
Q&A (Stack Overflow)	0.25
Mendeley readers	0 (Tracked but not considered in calculation)

\*Not trackable since 2019, but historical data kept. The total score is calculated as a function of the social media weights listed in the table. <sup>†</sup>Not trackable since 2015, but historical data kept.

**Table 2.** Bibliometric Characteristics of Included Articles

Bibliometric characteristics of included articles	Value (n = 118)
Journal	
<i>Journal of Bone &amp; Joint Surgery</i>	19 (16.0)
<i>Journal of Shoulder and Elbow Surgery</i>	51 (43.0)
Other	
Year of publication	48 (40.8)
Before 2017	50 (42.4)
After 2017 inclusive	
Open access	
No	68 (57.6)
Yes	82 (74.0)
Number of authors	36 (26.0)
Mean ± SD	5.96 ± 2.51
Median (range)	6.00 (1.00–18.0)
First author's degree	
MD/DO	91 (77.1)
Other	27 (22.9)
Number of institutions	
Mean ± SD	2.84 ± 2.32
Median (range)	2.00 (1.00–12.00)
Continent of origin	
North America	89 (75.4)
Europe	22 (18.6)
Asia	2 (1.7)
South America	4 (3.4)
Africa	0
Australia	1 (0.8)
Conflict of interest	
No	27 (22.9)
Yes	91 (77.1)
Study topic	
Basic science and biomechanics	29 (24.6)
Diagnostic/imaging	33 (28.0)
Clinical outcomes	56 (47.5)

**Table 2.** Continued

Bibliometric characteristics of included articles	Value (n = 118)
Number of citations	
Mean ± SD	77.8 ± 122
Median (range)	41 (0–867)
Number of references	
Mean ± SD	32.8 ± 15.3
Median (range)	31.5 (2.00–126)

Values are presented as number (%) unless otherwise indicated. SD: standard deviation.

the association between article characteristics and AAS. Statistical significance was defined as  $p < 0.05$ .

## RESULTS

The Altmetric Database query yielded 1,283 studies published between 1995 and 2022. After screening for articles that fit our inclusion criteria, this investigation utilized AAS to sequentially identify the 100 most impactful articles generating online attention that pertained to TSA. While applying our inclusion criteria sequentially starting at the highest AAS article, a total of 153 articles were excluded from the search, including 128 publications that were totally unrelated to TSA and 25 that did not focus on TSAs. As a result, a total of 118 articles were included in our final analysis.

The median number of years since publication was 5 years (interquartile range [IQR], 1–10 years). The overall mean and standard deviation for the AAS was  $29.14 \pm 42.35$ , with a range of 13 to 402 (median, 17). The included articles represented 27 journals, with 70 articles attributed to 2 journals and their open-access companions: *Journal of Shoulder and Elbow Surgery* (JSES; 43% [51 articles]) and the *Journal of Bone and Joint Surgery* (JBJS; 16% [19 articles]). The top 2 articles identified in this study had AAS scores that were substantially higher (AAS >200) than all other included articles, which were substantially lower (AAS <110). Both articles were population-based studies using national registries to identify the risk of serious adverse events following TSAs.<sup>15,16</sup> One of the articles was published in *British Journal of Sports Medicine* and the other in *Journal of the American Association of Orthopaedic Surgeons*. A complete summary of all included bibliometric and Altmetric characteristics can be found in Tables 2 and 3, respectively.

**Table 3.** Altmetric Characteristics of Included Articles

Altmetric characteristics of included articles	Value (n = 118)
Altmetric Attention Score	
Mean ± SD	29.1 ± 42.3
Median (range)	17.0 (13.0–402)
Twitter mentions	
No	21 (17.8)
Yes	97 (82.2)
Number of Twitter mentions	
Mean ± SD	12.2 ± 19.2
Median (range)	5.50 (0–150)
Facebook mentions	
No	78 (66.1)
Yes	40 (33.9)
Number of Facebook mentions	
Mean ± SD	0.63 ± 1.24
Median (range)	0 (0–7.00)
Blog mentions	
No	105 (89.0)
Yes	13 (11.0)
Number of blog mentions	
Mean ± SD	0.127 ± 0.404
Median (range)	0 (0–3.00)
News mentions	
No	32 (27.1)
Yes	86 (72.9)
Number of news mentions	
Mean ± SD	2.89 ± 5.85
Median (range)	1.00 (0–50.0)
Mendeley readership	
Mean ± SD	91.8 ± 78.2
Median (range)	77.5 (1.00–533)
Policy mentions	
No	97 (82.2)
Yes	21 (17.8)

**Table 3.** Continued

Altmetric characteristics of included articles	Value (n = 118)
Number of policy mentions	
Mean ± SD	0.229 ± 0.546
Median (range)	0 (0–3.00)
Patent mentions	
No	110 (93.2)
Yes	8 (6.8)
Number of patent mentions	
Mean ± SD	0.32 ± 1.55
Median (range)	0 (0–11.0)
Google Plus mentions	
No	112 (94.9)
Yes	6 (5.1)
Number of Google Plus mentions	
Mean ± SD	0.102 ± 0.605
Median (range)	0 (0–6.00)

Values are presented as number (%) unless otherwise indicated.  
SD: standard deviation.

The most common article type was original clinical research (82%), with the most common subgroup being retrospective cohort studies (n = 54; 56% of original research articles). The most common article topics were diagnostics/imaging (28%) and outcomes following TSA (47%). Of the included studies, 76% originated from within the USA, 19% originated from Europe, and 5% were published outside of the USA and Europe. A large portion of the included articles focused on both anatomic and reverse TSAs (62%).

A total of 1,436 Twitter mentions (median, 5.5; IQR, 1–21) and 74 Facebook mentions (median, 0; IQR, 0–1) were identified from the 118 included articles. A multi-variable linear regression model incorporating all bibliometric characteristics collected from included studies was constructed to determine the influence of each factor on the AAS (Table 4). This model demonstrated presence of a conflict of interest and open access status was statistically significant and associated with the AAS, with an additional mean increase in the AAS of 17.17 (95% confidence interval [CI], 2.72–31.62;  $p = 0.042$ ) and 3.61 (95% CI, 1.33–5.81;  $p < 0.01$ ), respectively. The regression analysis demonstrated that the citation rate was not significantly

**Table 4.** Multivariate Linear Regression Model for Key Publication Characteristics, Citations, and the Altmetric Attention Score

Variable	Regression coefficient	95% Confidence interval	p-value
Reference: subscription access			
Open Access	3.61	1.33 to 5.81	< 0.01*
Reference: No general COI			
COI	17.17	2.72 to 31.62	0.042*
Reference: Non-MD/DO <sup>†</sup>			
MD or DO	-4.64	-15.15 to 43.18	0.654
Reference: Not from North America			
Continent of origin: North America	5.78	-16.66 to 35.36	0.546
Reference: Before 2017			
Year: after and including 2017	13.53	-24.21 to 28.39	0.140
Number of authors	-3.39	-8.24 to 3.53	0.106
Number of institutions	2.22	-1.53 to 19.78	0.335
Number of references	0.22	-0.29 to 0.79	0.417
Number of citations	-0.02	-0.06 to 0.08	0.601

COI: conflict of interest.

\*Indicates statistical significance at  $p < 0.05$  level. <sup>†</sup>Other author degrees include BS, MS, PhD, MD PhD, MD MBA, MD MS, MD MPH, and PT.

associated with the AAS ( $p > 0.05$ ).

## DISCUSSION

Our study showed that the 100 most impactful articles on shoulder arthroplasty came mainly out of Europe and the USA, were mostly original clinical research, and focused mostly on both anatomic and reverse TSAs. Our findings also showed that the JSES and the JBJS contributed the highest number of articles in our list and that the presence of conflicts of interest and open access status were positively associated with higher AAS impact.

The vast majority of articles in our study came out of the USA and Europe. That comes as no surprise, as the vast investments in research and healthcare seen in the West rendered these countries pioneers in surgical and medical research worldwide.<sup>17)</sup> As such, it was found that the most impactful articles on shoulder arthroplasty were conducted by American or European surgeons. Previous research by Kunze et al found that publications from North America were associated with higher AAS when looking at articles published in 5 English-language orthopedic journals.<sup>18)</sup> That being said, however, our manuscript did not find any significant associations between the country of origin and AAS, probably due to the fact that our

study did not pose limitations on the journals included.

World-leading journals in the field of orthopedics often produce more impactful research and have high publication standards, and thus, it comes as no surprise that JSES and JBJS had the highest number of contributions from our list. JSES and JBJS are ranked 9th and 15th out of 306 journals in the field of Orthopedics and Sports Medicine, and are as such, considered elite journals, especially in the field of shoulder surgery.<sup>19)</sup> Social media promotion of such publications is often superior to those at low-tier journals and that could be due to the greater marketing prowess of such journals, the high standard of the articles published in them, and the high interest generated from their target audience. As a matter of fact, this trend has been mirrored by findings of other similar papers in the literature that explored social media interest in other orthopedics-related topics.<sup>11,13)</sup> For example, in an Altmetric analysis of top 100 cited papers on anterior cruciate ligament, Civilette et al.<sup>11)</sup> demonstrated that around two-thirds of the articles were published in the *American Journal of Sports Medicine* (AJSM), *British Journal of Sports Medicine*, and the *Journal of Orthopaedic and Sports Physical Therapy*.<sup>11)</sup> Another similar study by Kirloskar et al.<sup>13)</sup> explored medial ulnar collateral ligament and found that 72% of the articles were published in AJSM, JSES,

or *Orthopaedic Journal of Sports Medicine*. Hence, top-tier journals often have higher promotive force on social media, which can translate into higher AAS and social media interactions. That being said, even though journal IF, a highly utilized metric for measuring journal impact and significance, has been associated with AAS in other similar orthopedic studies,<sup>18,20</sup> our study did not show any significant association.

The majority of articles in our study were clinical research studies (82%), and this falls in accordance with other similar studies in literature.<sup>11,13</sup> Clinical research studies found in our study can provide valuable evidence-based information related to shoulder arthroplasty, like data on diagnostics and patient outcomes.<sup>21</sup> Such studies can impact patient management and care and are thus bound to generate much more interest to their target audience than other article types like review articles or basic science, especially in the field of shoulder arthroplasty. Moreover, while citation rate has been found to be significantly associated with AAS for the general orthopedic literature and hand surgery, no association was found in our study.<sup>10,14,22</sup> This can be explained by the fact that these studies excluded the articles published in the last 2.5–4 years in order to have more representative data on citation counts. Our study included all articles published up to the point of data collection, including 25 articles that were published within the last 3 years. As such, the more recent articles probably did not have enough time to accrue a fair number of citations so far, and this may have affected the association between citation count and AAS.

In our study, a significant association was found between AAS scores and open access status. This comes as no surprise, as open access articles are freely accessible and available to the scientific community, leading to higher readership and consequently higher interaction on social media platforms.<sup>23</sup> In addition, the presence of conflict of interest among authors was also associated with higher AAS scores. This can be explained by the fact that conflicted authors may have their research promoted by their industry partners, and this can help expand the reach of the published study, leading to more social media interac-

tions and higher AAS scores.

Our study is the first to explore the 100 shoulder arthroplasty publications with the highest AAS scores. Nevertheless, several limitations exist. First, there is an inherent bias for greater online attention for more recent publications, as social media platforms may not have been available for older articles. Second, several journals and authors use Instagram to promote their research online, but Instagram is not part of the AAS scoring system. Finally, while AAS can be an indicator of research impact and significance, it is important for the reader to know that AAS is more a measure of popularity rather than quality. Hence, readers should always be critical of the research at hand and not conflate AAS scores with quality scores.

Top articles on TSA, as defined by high AAS, mostly comprise original clinical research performed in the USA or Europe. The presence of a conflict of interest and open access status was associated with an increase in AAS, but there was no association between AAS score and citation rate.

## CONFLICT OF INTEREST

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