Research Study Characteristics Associated with Media Engagement in Hip and Knee Arthroplasty Database Studies

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Objectives: This study identified associations between a study's Altmetric Attention Score (AAS) and the number of times it was posted on X (formerly Twitter) with article characteristics such as the topic or publishing journal.

Design: Retrospective study

Main Outcome Measurements: AAS and X posts for each article were retrieved

Results: Kruskal-Wallis tests revealed a difference between an article's publishing journal and its AAS ($p = 0.034$) and number of X posts ($p = 0.032$), with articles published in the *Bone & Joint Journal* (*BJJ*) having the greatest mean AAS (16.27) and X posts (25.73). Kruskal-Wallis tests showed a difference between an article's topic and its AAS ($p = 0.001$) and number of X posts ($p = 0.027$), with articles focused on surgical techniques having the greatest mean AAS (26.50) and X posts (37.00).

Conclusions: There is significant variation in the degree of media engagement for hip and knee arthroplasty database studies. The topic of the article (surgical techniques) and journal of publication (*BJJ*) were associated with a greater level of engagement.

Level of Evidence: Level 4

Key Words: Arthroplasty research, Altmetrics, Administrative database, Clinical registry, X posts

INTRODUCTION

The number of orthopaedic publications has grown at a substantial rate over the past few years. A recent publication estimated a 3.1% growth in the number of orthopaedic publications from 2017 to 2018, 8.8% growth from 2018 to 2019, and a 22.4% growth from 2019 to 2020 [1]. The reasons for such growth are multifactorial including the increase in open access orthopaedic journals, the COVID-19 pandemic, the increased emphasis on research productivity for residency and fellowship applications, and the concept of "publish or perish" in the academic work environment [2, 3]. An additional factor that has contributed to this growth is the increased availability and utilization of multi-institutional administrative databases and clinical registries [4, 5]. In fact, database publications are growing at a faster rate than overall orthopaedic publications [6]. This is because they offer large sample sizes to study topics that are otherwise difficult to investigate, provide potentially "real-world" sampling that may be more representative of the general population than a randomized study with strict inclusion criteria, track data over long periods of time, and are incredibly affordable and quick to publish [7]. However, these studies are retrospective and observational, preventing them from accounting for confounders and establishing causation [8-10].

There is also an increased emphasis on measuring the impact of an article and communicating its findings. Although traditional bibliometrics such as citations remain important, other metrics such as traditional or social media mentions and the composite Altmetric Attention Score (AAS) continue to rise in importance as technology advances. The AAS measures the online attention an article has gathered by automatically tracking the online media presence and mentions an article receives on platforms such as news stories, blog posts, Facebook posts, and X posts. The composite score is derived from an automated algorithm and represents a weighted count of the amount of attention the article has received with different weights being allocated to different types of media platforms based on their relative reach [11]. For example, a news story is weighed as more

than an X post because it is more likely to attract greater attention (See Table 1 for breakdown of AAS).

Table 1: Weights of Media Platforms in Automated Algorithm for Altmetric Attention Score

Media Platform	Weight
News	8
Blog	5
Policy document (per source)	3
Patent	3
Wikipedia	3
Peer review (Publons, Pubpeer)	1
Weibo (not trackabble since 2015, but historical data kept)	1
Google+ (not trackable since 2019, but historical data kept)	1
F1000	1
Syllabi (Open Syllabus)	1
LinkedIn (not trackable since 2014, but historical data kept)	0.5
Twitter (tweets and retweets)	0.25
Facebook (only a curated list of public Pages)	0.25
Reddit	0.25
Pinterest (not trackable since 2013, but historical data kept)	0.25
Q&A (Stack Exchan)	0.25
YouTube	0.25
Number of Mendeley readers	0
Number of Dimensions and Web of Science citations	0

This metric and its measurements of online attention and media engagement are relevant to orthopaedic surgery for several reasons. To start with, it allows journals to monitor trends and identify popular articles, which may incentivize them to publish articles on similar topics to better engage their audience on their perceived interests [12]. Furthermore, both journals and authors are significantly invested in understanding the broader societal impact of their work. They also have strong motivations to demonstrate this impact to funding agencies, academic institutions, and healthcare organizations. The number of citations an article received is the traditional way this was measured [13], but this is limited by time for citations to accrue and visibility of their work. Social media greatly enhances the visibility of an article by informing people about one's research by simply posting it where it has a high likelihood of being viewed, liked, shared, and discussed given the fact that almost 80% of internet users report using social networking [14, 15]. Furthermore, there was nearly a tenfold increase in social networking use by adults from 2005 to 2015, with a significant increasing upward trend [15].

Besides serving as an opportunity to create awareness on topics such as unfavorable outcomes, authors are also able to use social media to gather real-time feedback and directly converse with fellow clinicians about their results and implications instead of waiting for months for a conference or letter to the editor [16]. An excellent and well-known example of the utility of social media in rapidly sharing research findings while combatting misinformation is the COVID-19 pandemic [17, 18], which may extend into specific orthopaedic topics as well [19, 20]. The AAS provides a way to measure this engagement in a more comprehensive way across various online platforms compared to citations. In addition, the AAS allows journals and authors to identify which articles receive coverage by public blogs and news stories, which helps to provide insights into which topics are of interest to the public and patient population beyond just the academic orthopaedic community [21]. Thus, the expansion of the Internet and social media in recent years has changed the way scientific information is disseminated and expanded the way in which the orthopaedic community communicates with itself online [22].

Given the recent surge in orthopaedic publications exploring the AAS as an alternative measurement to assess an article's ability to attract

attention [23-29], it is clear this is of interest to many within the orthopaedic community. However, it is still unclear which factors are associated with certain publications receiving more interest. This has not been investigated in the hip and knee arthroplasty database literature. Thus, we identified hip and knee arthroplasty studies using multi-institutional administrative databases or clinical registries published in 2020 in four reputable orthopaedic journals with a social media presence on X (formerly known as Twitter). This study's purpose was to identify associations between a database study's AAS and the number of times it was posted on X with articles characteristics such as its general topic, journal of publication, and the presence of causal language in the title and abstract. We hypothesized that greater article engagement would be associated with certain hip and knee arthroplasty topics and the presence of causal language but not with specific journals.

METHODS

Article Retrieval

The articles included in this analysis were collected by a prior publication [10]. Using PubMed, the authors identified and manually selected clinically oriented hip and knee arthroplasty studies using multi-institutional administrative databases or clinical registries published in 2020 in one of four orthopaedic journals: *Clinical Orthopedics and Related Research* (*CORR*), *The Bone & Joint Journal* (*BJJ*), *The Journal of Arthroplasty* (*JOA*), and *The Journal of Bone and Joint Surgery* (*JBJS*) [10]. Those journals were selected because they represent the top four orthopaedic journals publishing database studies on hip and knee arthroplasty [30].

Data Collection

Each article was allocated to one of five general topics based on its primary objective and content: surgical techniques, technology, medications and/or anesthesia, logistics, and complications and outcomes. The articles were all read and allocated to a category by the primary author. Any questions or difficult allocations were mediated by the senior author. These categories were chosen because they encompass the major clinical research topics in total joint arthroplasty. For example, surgical techniques included surgical approach and cementation, logistics included day of discharge, and complications and outcomes focused on patient comorbidities and their associations.

The presence of causal language in the title and abstract of all the articles was determined by a prior publication using the same set of articles. "Causal language was defined as when authors state or infer that a certain exposure or variable affects another variable or can lead to an outcome [10]." This article trait was included based on the high prevalence (79.3%) of causal language in these database publications, which prompted the authors to investigate if it was related to the amount of media attention a publication receives.

Next, the AAS and number of X posts for each article was retrieved using the Altmetric Bookmarklet tool. The online Altmetric Bookmarklet tool provides the number of mentions an article received on each individual media source, including total number of X posts. Since this data could change depending on how much time is allotted since publication, all data collection for AAS and X posts occurred during February 2023 to minimize time bias.

This study did not involve any human participants. Institutional review board approval was not needed.

Data Analyses

The percentages of articles published in each journal and general topic were calculated. The descriptive statistics of AAS and X posts were also calculated. Point-

biserial correlations were conducted to determine if there was a relationship between the presence of causal language in the title and abstract of an article and its AAS or number of X posts. Kruskal-Wallis H tests were performed to determine if there was an association between an article's number of X posts or AAS and its journal of publication or general topic. Statistical significance for a difference among groups when running Kruskal-Wallis H tests was set to $p = 0.05$. If statistical significance between groups was met with Kruskal-Wallis H tests, Dunn's pairwise tests were run as *post hoc* analyses to identify differences between pairs of groups with a Bonferroni corrected p value ($p = 0.0083$ for journals and $p = 0.005$ for general topics). Statistical analyses were performed using IBM SPSS Statistics Version: 28.0.1.1 (14; Armonk, NY, USA). This study's reporting adheres to the STROBE guidelines [31].

Of 116 eligible publications, 62.9% (73/116) of articles were published in *JOA*, 13.8% (16/116) in *JBJS*, 13.8% (16/116) in *CORR*, and 9.5% (11/116) in *BJJ*. For general topics, 56.0% (65/116) of articles were on complications and outcomes, 17.2% (20/116) were on technology, 11.2% (13/116) were on medications and/or anesthesia, 8.6% (10/116) were on logistics, and 6.9% (8/116) were on surgical techniques (See Appendix for dataset).

RESULTS

For the distribution of AAS, the range was from 0 to 80, and the mean was 8.33 with a 25th percentile of 0.25, 50th percentile of 4.00, 75th percentile of 11.75, and a standard deviation of 12.42 indicating moderate rightward skewness and kurtosis. In fact, 25.0% (29/116) of articles had an AAS of 0. For the distribution of X posts, the range was from 0 to 131, and the mean was 11.98 with a 25th percentile of 0, 50th percentile of 4.50, 75th percentile of 15.00, and a standard deviation of 20.07 indicated high rightward skewness and kurtosis. In fact,

27.6% (32/116) of articles had 0 posts on X as of February 2023.

Point-biserial correlations revealed no statistically significantly relationships between the presence of causal language in an article's title or abstract and its AAS ($r_{rb} = 0.045$, $p = 0.635$) or the number of X posts it received ($r_{rb} = 0.036$, $p = 0.703$).

A Kruskal-Wallis test demonstrated a difference ($H = 8.669$, $p = 0.034$) between the AAS of articles published in *BJJ*, *CORR*, *JBJS*, and *JOA*. Dunn's pairwise tests were carried out for the six pairs of groups and showed ($p = 0.004$) articles published in the *BJJ* (mean 16.27) had a greater AAS than those published in *JOA* (mean 7.05). There was no statistically significant evidence of a difference between the other pairs (See Table 2). Articles published in *CORR* and *JBJS* had a mean AAS of 9.63 and 7.38, respectively.

A Kruskal-Wallis test demonstrated a difference

Table 2: Dunn's Pairwise Comparisons of Altmetric Attention Scores Across Journals

Journal Comparisons	P value
JOA - BJJ	0.004*
CORR - BJJ	0.035
JBJS - BJJ	0.121
JOA - JBJS	0.254
JBJS - CORR	0.538
JOA - CORR	0.724
* Indicates statistical significance using Bonferroni corrected p-value of 0.0083	

($H = 8.832$, $p = 0.032$) between the number of X posts those articles received across the four journals. Dunn's pairwise tests showed that articles published in the *BJJ* had a higher mean number of X posts compared to those published in *JOA* ($p = 0.003$). *BJJ* had a mean number of posts of 25.73, *CORR* of 14.25, *JOA* of 10.40, and *JBJS* of 7.50. There were no other statistically significant differences (See Table 3).

Table 3: Dunn's Pairwise Comparisons of Number of X Posts Across Journals

Journal Comparisons	P value
JOA - BJJ	0.003*
CORR - BJJ	0.016
JBJS - BJJ	0.023
JOA - JBJS	0.828
CORR - JBJS	0.884
JOA - CORR	0.976
* Indicates statistical significance using Bonferroni corrected p value of 0.0083	

A Kruskal-Wallis test revealed a difference ($H = 17.635$, $p = 0.001$) of the AAS of articles in different topics. Dunn's pairwise tests were carried out for the 10 pairs and identified a statistically significant difference between articles on surgical techniques (mean 26.50) and those on logistics (mean 1.30, $p < 0.001$) and complications and outcomes (mean 7.82, $p = 0.002$). Articles on medications and/or anesthesia had a mean 5.92, and those on technology had a mean 7.80. There were no other statistically significant differences (See Table 4).

Table 4: Dunn's Pairwise Comparisons of Altmetric Attention Score Across General Topics

Topic Comparisons	P value
Logistics – Surgical Techniques	< 0.001*
Complications and Outcomes – Surgical Techniques	0.002*
Medications and/or Anesthesia – Surgical Technique	0.006
Technology – Surgical Techniques	0.007
Logistics – Complications and Outcomes	0.018
Logistics - Technology	0.029
Logistics – Medications and/or Anesthesia	0.071
Medications and/or Anesthesia - Technology	0.806
Complications and Outcomes - Technology	0.867
Medications and/or Anesthesia – Complications and Outcomes	0.883
* Indicates statistical significance using Bonferroni corrected p-value of 0.005	

A Kruskal-Wallis test showed a difference ($H = 10.972$, $p = 0.027$) between the number of X posts articles received across the different topics. Dunn's pairwise tests demonstrated a statistically significant difference between articles on surgical techniques (mean 37.00) and on logistics (mean 2.60, p = 0.001). Articles on medications and/or anesthesia had a mean 9.08, those on technology had a mean 10.70, and complications and outcomes had a mean 11.32 of X posts. There were no other statistically significant differences.

DISCUSSION

In hip and knee arthroplasty database articles published in 2020, there is a wide degree of variation in the amount of media engagement articles received. This work demonstrates that a small minority of articles received markedly higher AAS and X posts. The most popular (greatest AAS and number of X posts) article was published in *CORR* with 131 X posts and an AAS of 80. The authors utilized the Norwegian Hip Fracture Register to show uncemented hemiarthroplasties in elderly patients with hip fractures were associated with a high risk of reoperation due to periprosthetic fractures and infection compared to cemented hemiarthroplasties [32]. The second most popular article (97 X posts and an AAS of 60) was published in *JOA*, and the authors used the Humana insurance database from PearlDiver to demonstrate that prior knee arthroscopy was associated with greater rates of total knee arthroplasty revision, periprosthetic joint infection, and aseptic loosening [33]. Meanwhile, the third most popular article was published in *BJJ* with 88 X posts and an AAS of 50, and the authors used the Australian Orthopaedic Association National Joint Arthroplasty Registry to demonstrate comparable to superior short-term survivorship as well as a higher rate of early revision due to infection of robotically assisted unicompartmental knee arthroplasty (UKA) compared to

non-robotic UKA [34]. Lastly, the fourth most popular article was published in *BJJ* with 69 X posts and an AAS of 43, and the authors used the National Joint Registry for England, Wales, Northern Ireland, and the Isle of Man to demonstrate that antibiotic-loaded bone cement was associated with lower rates of revision due to prosthetic joint infection in total hip arthroplasty [35].

These four articles all used different databases and were distributed across three journals and general topics (surgical techniques, technology, and complications and outcomes). Although they all included large sample sizes and statistically significant findings, these are commonalities shared with most database studies. One noteworthy observation is all these articles shared a focus on the risk of surgical revision and infection associated with a certain exposure, which may partially explain the increase in attention. After all, this is a large concern for arthroplasty surgeons and researchers given the rising incidence in periprosthetic infections as a cause of revision for total joint arthroplasty [36, 37]. However, this finding is purely observational, and there were several papers concerned with revision or infection that did not receive the same degree of attention [38, 39].

Given the high prevalence of causal language in the observational orthopaedic literature [9, 10, 40], we postulated it was associated with the amount of media engagement an article received as a possible explanation for its use. We theorized stronger causal language would attract more attention and propagate more "clicks" in the academic orthopaedic community, but this did not appear to be the case. Thus, it is still unclear what the etiologies are for the use of causal language in observational database studies. It may be a combination of lack of awareness that these studies cannot establish causation, authors and readers being unfamiliar with the nuances between causal and non-causal language, or authors' propensity to use causal language for a perceived greater probability of publication or media attention.

It was particularly surprising that articles published in the *BJJ* had the highest mean AAS and X posts and *JBJS* had the second lowest AAS and least X posts, since from 2021 to 2022, *JBJS* had the highest impact factors, *BJJ* had the second highest, *CORR* had the third highest, and *JOA* had the lowest [41]. Furthermore, these results differ from an oncology study that identified journal impact factor as a factor associated with greater online media attention, measured by the AAS [42]. In addition, in 2023, *JBJS* had the greatest number of followers on X (~40,500), followed by *BJJ* (~33,100), *CORR* (~13,700), and then *JOA* (~12,600). Given the observational nature of this work, the causes behind this finding are unknown, but it may be due to journal posting practices with regards to frequency and article selection, media coverage of journals, the proportion of arthroplasty surgeons and researchers following each account, or just the overall nature of publications within a certain journal.

This work has limitations. The sample was limited to multi-institutional database studies on hip and knee arthroplasty published in four journals only in 2020, so the results are not applicable to the entirety of the arthroplasty literature. However, articles published in only one year were purposely included to minimize the effect of time on the studied metrics. All included articles had been published for over two years at the time of data collection, which was felt to be sufficient time to allow X posts and media coverage to accrue. However, results may be different in recent years given the expanding use of social media.

Another limitation is the reliance on the Altmetrics algorithm to accurately capture online mentions and X posts to generate its data. However, prior research has found components of Altmetrics data to be reliable [43]. Furthermore, many reputable scientific journals have incorporated Altmetrics or other similar media engagement scoring systems such as PlumX Metrics on their own editorial website to demonstrate

social impact of articles. In addition, one of the authors went through all the X posts for each article to ensure there were no duplicates or mistakes, and there were no detected errors. Thus, we feel the metric is reliable enough to represent social engagement. One significant limitation is the subjectivity of allocating articles into one category, as some articles had topics that could have been listed in multiple. Thus, articles were allocated based on their most predominant characteristic. Based on this subjective criteria and potential bias, a very conservative Bonferroni corrected *p* value of 0.005 was used when determining relationships. Unfortunately, we are unaware of any standardized categories generated by arthroplasty journals or organizations to classify articles based on their topic. The establishment of such a classification scheme would certainly improve research on this topic given the numerous articles that have had to generate their own classifications to study characteristics associated with article engagement [44, 45].

Lastly, this work focused on X as the primary social media platform and did not perform any analyses for other social media platforms such as Facebook, Instagram, LinkedIn, YouTube, or Reddit for a variety of reasons. We originally collected all the data Altmetrics provided for each article, including Facebook and Reddit posts as well as YouTube videos. However, Altmetrics detected zero articles with references in YouTube or Reddit. It only detected 30 Facebook posts distributed across 19 articles (16% of the total sample) with a range of 0-4 posts per article. Given these low numbers, statistical analyses were deferred. In terms of Instagram and LinkedIn, it is unlikely that engagement is greater on those platforms given the fact that the included journals in this study have significantly greater followers and posts (1.4 - 9.9 and 2.8- 4.0 times greater, respectively) on X compared to Instagram and LinkedIn. Given the importance of journals promoting articles for enhanced sharing, it is highly unlikely that greater engagement

occurs when these journal accounts receive less attention. Furthermore, X's format as a social microblogging platform allows for easy sharing of links and interactions through reposts, replies, and mentions, which lends itself very well to sharing and discussing research. Meanwhile, Instagram is heavily reliant on photos, and LinkedIn is more of a formal professional networking site. Thus, we considered X to be the most popular social media platform for researchers to share and discuss their work, consistent with prior research [46-48].

CONCLUSION

In observational hip and knee arthroplasty database articles published in 2020 across four top orthopaedic journals, there is significant variation in the amount of media engagement that articles receive. The journal of publication (*BJJ*) and topic of article (surgical techniques) were associated with greater media engagement, while causal language was not. Authors should be aware of the differing degrees of media attention awarded to articles based on their characteristics.

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