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Original Research

Evaluation of the Correlation between Altmetric Attention Score and Citation Number of Top 50 Articles in Orthopedics

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Abstract

The altmetric Attention Score scale quantifies the attention that publications receive on various social media. Some studies have been conducted on the correlation between AAS and citations of articles in other disciplines but orthopedics. This study aimed to compare AAS with citation numbers on the top 50 articles regarding citation numbers. For this study the Scopus database was searched for the most 50 cited manuscripts on orthopedics from January 2015 to December 2020. Subsequently, altimetric attention score (AAS) and the number of Tweeters, Dimensions, etc, were retrieved for each article through "Bookmarklet for Researchers" at Altmetric.com. Results show a statistically low and non-significant relationship was indicated between the citation number and the AAS and also shown the linear relationship between the mention on Twitter and the altmetric attention score. Most of previous articles represented that there is a weak to moderate relationship between the citation number and the AAS that is similar to our findings. There is a low but significant correlation exists between the AAS and the number of citations. In addition, the AAS is directly and linearly linked to the number of mentions on Twitter.

Keywords: Altmetric Attention Score, Orthopedics, Citation.

Introduction

Traditionally, the assessment of the scientific study's quality was mainly based on bibliometric factors such as article citation number, the impact factor of the journal, and the h-index (Ramamurti et al., 2021). In recent years, the development of social media has made data available more and more. Thus, the impact of research is exhibited on the bibliometric, i.e., the impact factor of the journals publishing studies, and relies on the effects of research on social media, i.e., Mendeley and Twitter (Bornmann, 2015). Accuracy in quantifying the quality of publications is essential for assessing researchers' and academic journals' performance. In addition, accurate tools help us to recognize the best publications in each field (Moon et al., 2020).

Altmetric has some benefits as opposed to bibliometric: (1) publication impact is not limited to academia and citation and goes beyond them, and (2) various types of less common content, i.e., software, can be assessed more realistically (Kunze et al., 2020). Besides, altmetric allows us to assess a study's impact sooner than traditional bibliometrics, some weeks instead of some years (Bornmann, 2014). The altmetric Attention Score (AAS) scale quantifies the attention publications receive on various social media platforms, such as Facebook, Wikipedia, and blogs (Mirghaderi, Baghdadi, Salimi, & Shafiei, 2022; Moon et al., 2020). Although some studies have been conducted on the correlation between AAS and citations of articles in several disciplines, such as emergency medicine (Barbic, Tubman, Lam & Barbic, 2016), neurosurgery (Wang, Alotaibi, Ibrahim, Kulkarni & Lozano, 2017), neuroimaging (Kim et al., 2019), and central nervous system inflammatory demyelinating disease (Kim, Kim, Park, Yoon & Bae, 2019), this correlation is not fully clear in the orthopedic articles.

As a result of the growing popularity of social media in scientific fields, social attention to scientific articles has become significant. Twitter, Facebook, and other social media platforms are essential for getting articles out (Chandawarkar, Gould & Grant Stevens, 2018). AAS is a rating given to the real-time online interest of articles and might replicate the volume in their spread on social networks. There are three advantages to checking AAS: Firstly, researchers, institutions, and journals can easily use social media metrics to monitor the overall research impact on time. Secondly, this parameter may be used to assess different ways of disseminating knowledge. Third, social media impact measures can also serve as a filter to direct users to research articles of public interest (Eysenbach, 2011).

O'Connor, Nason, O'Kelly, Manecksha and Loeb (2017) questioned whether the most cited urological documents were most widely distributed in the media. They concluded that top papers based on Altmetric scores were not cited widely. A study reviewing cardiovascular articles published in the journals with the highest impact factors represented that AAS seemed to have a moderate relationship with citation numbers at three years (Barakat et al., 2018). A Study performed in pediatric surgery concluded that the altmetric score of the top articles is not related to the journal's impact factor but is weakly related to the number of citations (Chang, Desai & Gosain, 2019). Costas, Zahedi and Wouters (2015) noted that citations are strongly correlated with AAS. However, other studies have shown that associations among AAS, citation rates, and journal impact factors are low (Barbic et al., 2016; O'Connor et al., 2017; Rosenkrantz, Ayoola, Singh & Duszak, 2017).

Furthermore, 1.3 million articles published in 2012 reviewed by Haustein, Costas, and Larivière (2015) correlated the number of references and social media measurements. Therefore, we assumed there could be a relation between citations and ASA in orthopedics. Therefore, this study aimed to compare AAS with citation numbers on the top 50 articles regarding citation numbers.

Materials and Methods

At first, the Scopus database was searched for the most cited manuscripts on orthopedics from January 2015 to December 2020 with the keyword “orthopaedic”. Initially, we selected

50 articles and left unrelated items, leaving 24 items we extracted information. The following items, including the first Author, journal type of article, year of publication, accessibility, country, and citation number, have been compiled for all twenty-four included articles. Subsequently, altimetric attention score (AAS) and the number of Tweeters, Dimensions, and readers on Mendeley, Facebook pages, policy sources, news outlets, blogs, patents, Wikipedia pages, research highlight platforms, and Redditors were retrieved for each article through "Bookmarklet for Researchers" at Altmetric.com. These data are given in order of citations in Table 3. The data were analyzed using appropriate statistical tests. The median and the ranges of values (minimum-maximum) were used to describe data. We used a Kruskal-Wallis test to compare Altmetric scores among different categories since the study data were not normally distributed. The Spearman rank correlation coefficient was used to describe the correlation between study variables. Data analysis was performed in SPSS v.21.

Results

The top 24 most cited orthopedic articles in the Scopus database from 2015 to 2020 were reviewed in the current study. Among the identified articles, the *Biomaterials* journal had the most identified articles (n=3, 12.5%) (Table 1).

Table 1
Comparison of article sources according to the type of journals

Journal	N*	IF2019	Q2019
Clinical Infectious Diseases	1	6.81	1
BioMedical Engineering Online	1	2.48	2
New England Journal of Medicine	1	40.14	1
Journal of Orthopaedic Research	2	2.86	1
Materials Science and Engineering C	2	6.25	1
Materials	2	3.26	2
Advanced Drug Delivery Reviews	1	13.49	1
Bioactive Materials	1	9.316	1
JAMA - Journal of the American Medical Association	1	11.38	1
The Lancet	2	44.9	1
Biomaterials	3	10.87	1
Clinical Microbiology and Infection	1	7.12	1
Acta Materialia	1	8.22	1
Nature Reviews Microbiology	1	21.58	1
Nature Medicine	1	28.95	1
Bone	1	4.13	1
European Journal of Anaesthesiology	1	3.9	1
Express Polymer Letters	1	3.29	1
Proceedings of the National Academy of Sciences of the United States of America	1	9.35	1
American Journal of Sports Medicine	2	6.11	1
British Journal of Sports Medicine	1	10.46	1
Nanotechnology	1	3.54	1

*Number of study articles published in each journal

The maximum citation number was 706 (with a big difference from the second rank), and the minimum was 227. The number of original and review articles was 5 and 19, respectively (20.83% vs. 79.17%), and 79.17% (n=19) of all items paid for free. Through these 24, the subject "orthopedic devices" was repeated 14 times (58.33%) (Table 2).

Table 2
list of 50 most cited articles in Scopus in 2015-2020

ID	Title	First Author	Journal	Type of article	Year	Open Access	country	Subject	Citation number
1	Topological design and additive manufacturing of porous metals for bone scaffolds and orthopaedic implants: A review (Wang et al., 2016)	Wang X.	Biomaterials	Review	2016	Yes	Australia	Orthopedic devices	706
2	Laser and electron-beam powder-bed additive manufacturing of metallic implants: A review on processes, materials, and designs (Sing, An, Yeong & Wiria, 2016)	Sing S.L.	Journal of Orthopaedic Research	Review	2016	Yes	Singapore	orthopedic devices	376
3	Bone grafts and biomaterials substitute for bone defect repair: A review (Wang & Yeung, 2017)	Wang W.	Bioactive Materials	Review	2017	Yes	China	treatment	367
4	Inflammation, fracture and bone repair (Loi, Córdova, Pajarinen, Lin, Yao & Goodman, 2016)	Loi F.	Bone	Review	2016	Yes	United States	bone fx	353
5	Implant infections: Adhesion, biofilm formation and immune evasion (Arciola, Campoccia & Montanaro, 2018)	Arciola C.R.	Nature Reviews Microbiology	Review	2018	No	Italy	orthopedic devices	346
6	Risk of Secondary Injury in Younger Athletes after Anterior Cruciate Ligament Reconstruction (Wiggins, Grandhi, Schneider, Stanfield, Webster & Myer, 2016)	Wiggins A.J.	American Journal of Sports Medicine	Review	2016	Yes	United States	treatment	324
7	Biodegradable magnesium alloys for orthopaedic applications: A	Agarwal S.	Materials Science and Engineering C	Review	2016	No	Ireland	Orthopedic devices	322

ID	Title	First Author	Journal	Type of article	Year	Open Access	country	Subject	Citation number
	review on corrosion, biocompatibility and surface modifications (Agarwal, Curtin, Duffy & Jaiswal, 2016)								
8	Multifunctional coatings simultaneously promote osseointegration and prevent infection of orthopaedic implants (Raphel, Holodniy, Goodman & Heilshorn, 2016)	Raphel J.	Biomaterials	Review	2016	Yes	United States	orthopedic devices	322
9	Current status on clinical applications of magnesium-based orthopaedic implants: A review from the clinical translational perspective (Zhao, Witte, Lu, Wang & Qin, 2017)	Zhao D.	Biomaterials	Review	2017	Yes	China	orthopedic devices	319
10	Regenerative medicine: Current therapies and future directions (Mao & Mooney, 2015)	Mao A.S.	Proceedings of the National Academy of Sciences of the United States of America	Review	2015	Yes	United States	treatment	300
11	Effect of pore size on bone ingrowth into porous titanium implants fabricated by additive manufacturing: An in vivo experiment (Taniguchi et al., 2016)	Taniguchi N.	Materials Science and Engineering C	Original	2016	No	Japan	orthopedic devices	295
12	2015 Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults (Berbari et al., 2015)	Berbari E.F.	Clinical Infectious Diseases	Review	2015	Yes	United States	treatment	293
13	The Warwick Agreement on femoroacetabular impingement	Griffin D.R.	British Journal of Sports Medicine	Consensus statement	2016	Yes	United kingdom	orthopedic disease	286

ID	Title	First Author	Journal	Type of article	Year	Open Access	country	Subject	Citation number
	syndrome (FAI syndrome): An international consensus statement(Griffin et al., 2016)								
14	Biomaterial strategies for engineering implants for enhanced osseointegration and bone repair (Agarwal & García, 2015)	Agarwal R.	Advanced Drug Delivery Reviews	Review	2015	Yes	United states	orthopedic devices	276
15	Titanium nanostructures for biomedical applications (Kulkarni et al., 2015)	Kulkarni M.	Nanotechnology	Review	2015	Yes	Germany	orthopedic devices	273
16	Implant-derived magnesium induces local neuronal production of CGRP to improve bone-fracture healing in rats (Zhang et al., 2016)	Zhang Y.	Nature Medicine	Original	2016	Yes	China	orthopedic devices	271
17	Comprehensive geriatric care for patients with hip fractures: A prospective, randomized, controlled trial (Prestmo et al., 2015)	Prestmo A.	The Lancet	Original	2015	No	Norway	orthopedic disease	265
18	Biodegradable materials for bone repair and tissue engineering applications (Sheikh et al., 2015)	Sheikh Z.	Materials	Review	2015	Yes	Canada	orthopedic devices	263
19	Bacteria antibiotic resistance: New challenges and opportunities for implant-associated orthopedic infections (Li & Webster, 2018)	Li B.	Journal of Orthopaedic Research	Review	2018	Yes	United states	orthopedic devices	256
20	A randomized, controlled trial of total knee replacement (Skou et al., 2015)	Skou S.T.	New England Journal of Medicine	Original	2015	Yes	Denmark	orthopedic surgery	253
21	Calcium phosphate bioceramics: A review of their history, structure, properties, coating technologies and	Eliaz N.	Materials	Review	2017	Yes	Israel	orthopedic devices	252

ID	Title	First Author	Journal	Type of article	Year	Open Access	country	Subject	Citation number
	biomedical applications (Eliaz & Metoki, 2017)								
22	Periprosthetic joint infection (Kapadia, Berg, Daley, Fritz, Bhave & Mont, 2016)	Kapadia B.H.	The Lancet	Review	2016	No	United states	orthopedic devices	246
23	Biologics for tendon repair (Docheva, Müller, Majewski & Evans, 2015)	Docheva D.	Advanced Drug Delivery Reviews	Review	2015	Yes	Germany	orthopedic surgery	242
24	Risk factors and predictors of subsequent ACL injury in either knee after ACL reconstruction: Prospective analysis of 2488 primary ACL reconstructions from the MOON cohort (Kaeding, Pedroza, Reinke, Huston, Consortium & Spindler, 2015)	Kaeding C.C., Pedroza A.D., Reinke E.K., etal.	American Journal of Sports Medicine	original	2015	yes	United state	Orthopedic surgery	227

The AAS point for the most cited articles varies between 503 and zero. One article was found to have an AAS of zero (Table 3). Surprisingly, the most cited article had an AAS number of 5, and the highest AAS score belonged to the thirteenth article in terms of citation. The number of mentions on the various social media is summarized in Table 3, in order of the AAS rating.

Table 3
Altimetric attention score for the most cited articles

ID*	AAS **	Tweeters	Dimensions	Mendeley	Facebook pages	policy sources	news outlets	blogs	patents	Wikipedia pages	research highlight platform	Redditors
13	503	705	354	874	58	0	0	2	0	2	0	0
20	466	388	277	675	40	3	18	11	0	0	0	1
6	179	238	374	650	11	0	2	0	0	0	0	0
17	179	197	296	382	10	1	2	4	4	0	0	0
5	93	126	356	624	7	0	2	1	0	0	0	0
10	81	6	319	992	1	0	8	2	0	0	0	0

ID*	AAS **	Tweeters	Dimensions	Mendeley	Facebook pages	policy sources	news outlets	blogs	patents	Wikipedia pages	research highlight platform	Redditors
12	75	73	345	625	4	1	2	2	0	0	0	0
24	44	61	252	335	3	0	1	0	0	0	0	0
4	19	36	391	600	0	0	0	0	0	0	0	0
3	10	1	387	1180	1	0	1	0	0	0	0	0
9	10	1	294	366	0	2	0	0	1	0	0	0
11	9	4	290	526	0	0	0	0	2	0	0	0
14	9	5	278	467	0	0	0	0	2	0	0	0
1	5	1	687	1352	0	0	0	0	0	0	0	0
8	4	1	296	444	0	0	0	0	1	0	0	0
15	4	1	245	407	0	0	0	0	1	0	0	0
23	4	2	266	516	0	0	0	0	0	0	0	0
19	3	4	259	617	1	0	0	0	0	0	0	0
22	3	3	51	101	0	0	0	0	0	0	0	0
2	2	3	386	859	1	0	0	0	0	0	0	0
16	1	0	12	29	1	0	0	0	0	0	0	0
18	1	1	282	568	0	0	0	0	0	0	0	0
21	1	1	269	618	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0

*ID: Citation rank; **AAS: Altmetric Attention Score (ASS)

The relationship between the citation number and the AAS is shown in Figure 1. R2 and p-value were 0.021 and 0.509, respectively, indicating a statistically low and non-significant relationship between these two indicators.

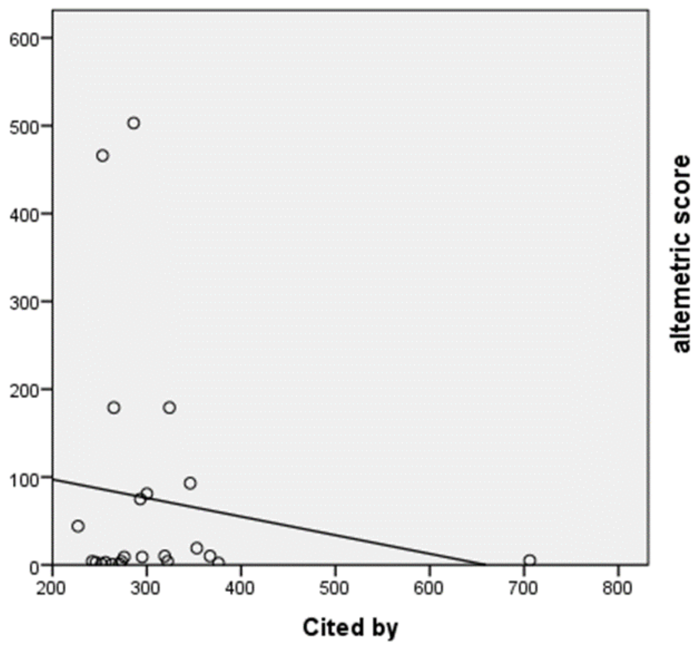

Figure1: Relationship between citations (in Scopus) and altmetric attention scores (AAS) for all papers

Figure 2 shows the linear relationship between the mention on Twitter and the altmetric attention score. So it suggests that the number of mentions on Twitter can be a good predictor of the final AAS (R2=0.923, p-value<0.001).

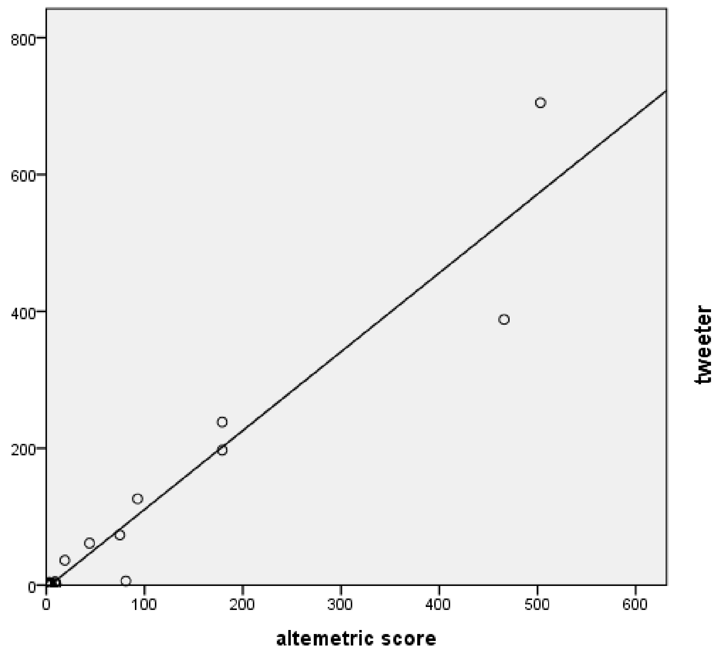

Figure 2: Relationship between Altmetric attention scores (AAS) and mentions on Tweeters in all papers

In Table 4, using Mann Whitney non-parametric statistical test, the mean, minimum, and maximum of the citation number and altimetric attention score in the two groups of journals are compared based on free accessibility. Based on the results, the differences in the indices mentioned above between the two groups were insignificant in all cases (Table 4).

Table 4
Comparison of sciencemetric and altmetric indexes according to journals' accessibility status

	Open Access		
	No, Median (min-max)	Yes, Median (min-max)	p-value
Cited by	346(246-706)	276(227-367)	0.101
Altmetric Attention Score	5(2-93)	9(0-503)	0.718
Tweeters	3(1-126)	4(0-705)	0.613
Blogs	0(0-1)	0(0-11)	0.640
policy sources	0(0-2)	0(0-3)	0.772
news outlets	0(0-2)	0(0-18)	0.559
Facebook pages	0(0-7)	1(0-58)	0.565
Readers on Mendely	624(101-1352)	568(0-1180)	0.731
Dimensions	356(51-687)	282(0-391)	0.230

The journal's impact factor did not demonstrate a significant relationship to the AAS of the papers (R2=0.125, p-value=0.090) (Figure 3).

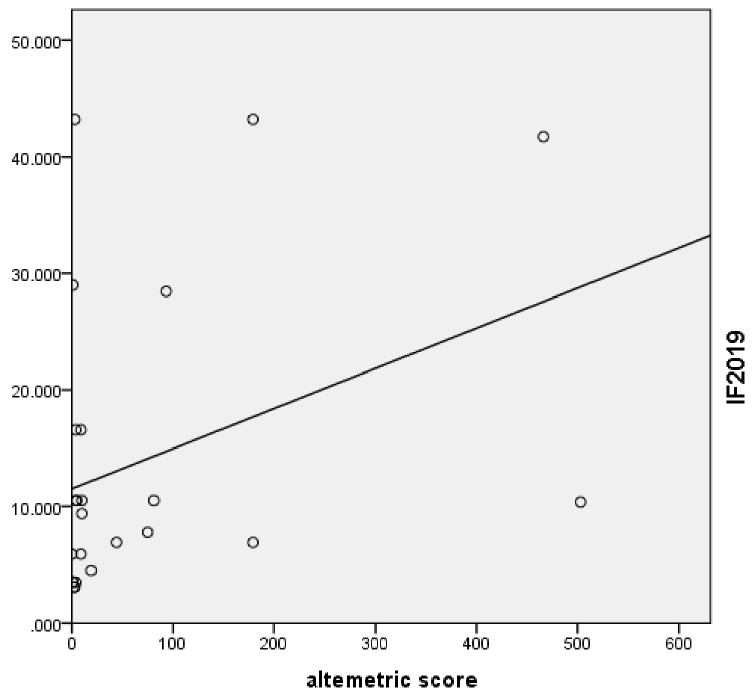

Figure 3: Relationship between journals' impact factor (in 2019) and Altmetric attention score

Discussion

In the current study, we checked on the best 24 articles in orthopedics as indicated by their citation number and assessed the connection between the citation number and AAS. Our results have shown a low but statistically significant correlation between the number of citations and the AAS that is similar to most of the previous studies (Barakat et al., 2018; Barbic et al., 2016; Chang et al., 2019; Costas et al., 2015; O'Connor et al., 2017; Rosenkrantz et al., 2017) (Figure 1). Consequently, social media does not appear inefficient in disseminating published articles. A linear relationship was also found between the number of mentions on Twitter and the AAS (Figure 2); This demonstrates that Twitter can play an important role in spreading the papers on social media. The results presented in Table 4 show that viewing articles in both the scientific and non-academic communities was not associated with open access. However, in our study, the number of studies with non-free access was only five, and it is suggested that this hypothesis be examined in a larger number of studies for more accurate conclusions in future studies.

Our study had certain limitations. Firstly, reviewing the 24 major articles about orthopedics may not be a good representation of the millions of articles published in various journals, but that was the best option we could do. It is, therefore, quite likely that our conclusions, especially concerning influential articles, will be accurate. Secondly, it is worth noting that sharing articles online, as opposed to the number of citations, does not necessarily mean reading them. Hence, it is preferable to think of AAS as simply spreading an article on social media, not reading it. Despite all the limitations of our study, we believe that the results obtained can provide a starting point for scientists wishing to publish their studies more broadly.

Conclusion

A review of the top 24 orthopedic papers led us to conclude that a low but significant correlation exists between the AAS and the number of citations. In addition, the AAS is directly and linearly linked to the number of mentions on Twitter. Accordingly, it is a point for scientists that spreading an article on social media, particularly Twitter, can do their research more broadly read. It should be noted that the journal impact factor did not have any significant effect on AAS.

References

Agarwal, R. & García, A. J. (2015). Biomaterial strategies for engineering implants for enhanced osseointegration and bone repair. *Advanced Drug Delivery Reviews*, 94, 53-62. https://doi.org/10.1016/j.addr.2015.03.013

Agarwal, S., Curtin, J., Duffy, B. & Jaiswal, S. (2016). Biodegradable magnesium alloys for orthopaedic applications: A review on corrosion, biocompatibility and surface modifications. *Materials Science and Engineering: C*, 68, 948-963. https://doi.org/10.1016/j.msec.2016.06.020

Arciola, C. R., Campoccia, D. & Montanaro, L. (2018). Implant infections: adhesion, biofilm formation and immune evasion. *Nature Reviews Microbiology*, 16(7), 397-409. https://doi.org/10.1038/s41579-018-0019-y

Barakat, A. F., Nimri, N., Shokr, M., Mahtta, D., Mansoor, H., Mojadidi, M. K., Mahmoud, A. N., Senussi, M., Masri, A. & Elgendy, I. Y. (2018). Correlation of altmetric attention score with article citations in cardiovascular research. *Journal of the American College of Cardiology*, 72(8), 952-953. https://doi.org/10.1016/j.jacc.2018.05.062

Barbic, D., Tubman, M., Lam, H. & Barbic, S. (2016). An Analysis of Altmetrics in Emergency Medicine. *Acad Emerg Med*, 23(3), 251-268. https://doi.org/10.1111/acem.12898

Berbari, E. F., Kanj, S. S., Kowalski, T. J., Darouiche, R. O., Widmer, A. F., Schmitt, S. K., Hendershot, E. F., Holtom, P. D., Huddleston, P. M. & Petermann, G. W. (2015). 2015 infectious diseases society of America (IDSA) clinical practice guidelines for the diagnosis and treatment of native vertebral osteomyelitis in adultsa. *Clinical Infectious Diseases*, 61(6), e26-e46. https://doi.org/https://doi.org/10.1093/cid/civ482

Bornmann, L. (2014). Do altmetrics point to the broader impact of research? An overview of benefits and disadvantages of altmetrics. *Journal of Informetrics*, 8(4), 895-903. https://doi.org/https://doi.org/10.1016/j.joi.2014.09.005

Bornmann, L. (2015). Alternative metrics in scientometrics: a meta-analysis of research into three altmetrics. *Scientometrics*, 103(3), 1123-1144. https://doi.org/10.1007/s11192-015-1565-y

Chandawarkar, A. A., Gould, D. J. & Grant Stevens, W. (2018). The top 100 social media influencers in plastic surgery on Twitter: who should you be following? *Aesthetic Surgery Journal*, 38(8), 913-917. https://doi.org/10.1093/asj/sjy024

Chang, J., Desai, N. & Gosain, A. (2019). Correlation between altmetric score and citations in pediatric surgery core journals. *Journal of Surgical Research*, 243, 52-58. https://doi.org/10.1016/j.jss.2019.05.010

Costas, R., Zahedi, Z. & Wouters, P. (2015). Do "altmetrics" correlate with citations? Extensive comparison of altmetric indicators with citations from a multidisciplinary perspective. *Journal of the Association for Information Science and Technology*, 66(10), 2003-2019. https://doi.org/10.1002/asi.23309

Docheva, D., Müller, S. A., Majewski, M. & Evans, C. H. (2015). Biologics for tendon repair. *Advanced Drug Delivery Reviews*, 84, 222-239. https://doi.org/10.1016/j.addr.2014.11.015

Eliaz, N. & Metoki, N. (2017). Calcium phosphate bioceramics: a review of their history, structure, properties, coating technologies and biomedical applications. *Materials*, 10(4), 334. https://doi.org/10.3390/ma10040334

Eysenbach, G. (2011). Can tweets predict citations? Metrics of social impact based on Twitter and correlation with traditional metrics of scientific impact. *Journal of medical Internet research*, 13(4), e2012. https://doi.org/10.2196/jmir.2012

Griffin, D., Dickenson, E., O'donnell, J., Awan, T., Beck, M., Clohisy, J., Dijkstra, H., Falvey, E., Gimpel, M. & Hinman, R. (2016). The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): an international consensus statement. *British Journal Of Sports Medicine*, 50(19), 1169-1176. https://doi.org/10.1136/bjsports-2016-096743

Haustein, S., Costas, R. & Larivière, V. (2015). Characterizing social media metrics of scholarly papers: The effect of document properties and collaboration patterns. *PloS one*, 10(3), e0120495. https://doi.org/10.1371/journal.pone.0120495

Kaeding, C. C., Pedroza, A. D., Reinke, E. K., Huston, L. J., Consortium, M. & Spindler, K. P. (2015). Risk factors and predictors of subsequent ACL injury in either knee after ACL reconstruction: prospective analysis of 2488 primary ACL reconstructions from the MOON cohort. *The American Journal Of Sports Medicine*, 43(7), 1583-1590. https://doi.org/10.1177/0363546515578836

Kapadia, B. H., Berg, R. A., Daley, J. A., Fritz, J., Bhave, A. & Mont, M. A. (2016). Periprosthetic joint infection. *The Lancet*, 387(10016), 386-394. https://doi.org/10.1302/2058-5241.4.180092

Kim, E. S., Yoon, D. Y., Kim, H. J., Lee, K., Kim, Y., Bae, J. S. & Lee, J. H. (2019). The most mentioned neuroimaging articles in online media: a bibliometric analysis of the top 100 articles with the highest Altmetric Attention Scores. *Acta Radiol*, 60(12), 1680-1686. https://doi.org/10.1177/0284185119843226

Kim, J.-E., Kim, Y., Park, K. M., Yoon, D. Y. & Bae, J. S. (2019). Top 100 Publications as Measured by Altmetrics in the Field of Central Nervous System Inflammatory Demyelinating Disease. BioMed Research International, 2019, 3748091. https://doi.org/10.1155/2019/3748091

Kulkarni, M., Mazare, A., Gongadze, E., Perutkova, Š., Kralj-Iglič, V., Milošev, I., Schmuki, P., Iglič, A. & Mozetič, M. (2015). Titanium nanostructures for biomedical applications. *Nanotechnology*, 26(6), 062002. https://doi.org/10.1088/0957-4484/26/6/062002

Kunze, K. N., Polce, E. M., Vadhera, A., Williams, B. T., Nwachukwu, B. U., Nho, S. J. & Chahla, J. (2020). What Is the Predictive Ability and Academic Impact of the Altmetrics Score and Social Media Attention? *The American Journal of Sports Medicine*, 48(5), 1056-1062. https://doi.org/10.1177/0363546520903703

Li, B. & Webster, T. J. (2018). Bacteria antibiotic resistance: New challenges and opportunities for implant-associated orthopedic infections. *Journal of Orthopaedic Research®*, 36(1), 22-32. https://doi.org/10.1002/jor.23656

Loi, F., Córdova, L. A., Pajarinen, J., Lin, T.-h., Yao, Z. & Goodman, S. B. (2016). Inflammation, fracture and bone repair. *Bone*, 86, 119-130. https://doi.org/10.1016/j.bone.2016.02.020

Mao, A. S. & Mooney, D. J. (2015). Regenerative medicine: current therapies and future directions. In *Proceedings of the National Academy of Sciences*, 112 (47), (pp. 14452-14459). https://doi.org/10.1073/pnas.1508520112

Mirghaderi, S. P., Baghdadi, S., Salimi, M. & Shafiei, S. H. (2022). Scientometric analysis of the top 50 most-cited joint arthroplasty papers: traditional vs altmetric measures. *Arthroplasty today*, 15, 81-92. https://doi.org/10.1016/j.artd.2022.03.001

Moon, J. Y., Yun, E. J., Yoon, D. Y., Seo, Y. L., Cho, Y. K., Lim, K. J. & Hong, J. H. (2020). Analysis of the altmetric top 100 articles with the highest altmetric attention scores in medical imaging journals. *Jpn J Radiol*, 38(7), 630-635. https://doi.org/10.1007/s11604-020-00946-0

O'Connor, E. M., Nason, G. J., O'Kelly, F., Manecksha, R. P. & Loeb, S. (2017). Newsworthiness vs scientific impact: are the most highly cited urology papers the most widely disseminated in the media? *BJU international*, 120(3), 441-454. https://doi.org/10.1111/bju.13881

Prestmo, A., Hagen, G., Sletvold, O., Helbostad, J. L., Thingstad, P., Taraldsen, K., Lydersen, S., Halsteinli, V., Saltnes, T. & Lamb, S. E. (2015). Comprehensive geriatric care for patients with hip fractures: a prospective, randomised, controlled trial. *The Lancet*, 385(9978), 1623-1633. https://doi.org/10.1016/S0140-6736(14)62409-0

Ramamurti, P., Gu, A., Fassihi, S. C., Stake, S., Wei, C., Campbell, J. & Thakkar, S. (2021). Correlation Between Altmetric Score and Traditional Bibliometrics in Total Joint Arthroplasty Research. *Arthroplasty Today*, 7, 225-229. https://doi.org/10.1016/j.artd.2020.12.030

Raphel, J., Holodniy, M., Goodman, S. B. & Heilshorn, S. C. (2016). Multifunctional coatings to simultaneously promote osseointegration and prevent infection of orthopaedic implants. *Biomaterials*, 84, 301-314. https://doi.org/10.1016/j.biomaterials.2016.01.016

Rosenkrantz, A. B., Ayoola, A., Singh, K. & Duszak Jr, R. (2017). Alternative metrics ("altmetrics") for assessing article impact in popular general radiology journals. *Academic Radiology*, 24(7), 891-897. https://doi.org/10.1016/j.acra.2016.11.019

Sheikh, Z., Najeeb, S., Khurshid, Z., Verma, V., Rashid, H. & Glogauer, M. (2015). Biodegradable materials for bone repair and tissue engineering applications. *Materials*, 8(9), 5744-5794. https://doi.org/10.3390/ma8095273

Sing, S. L., An, J., Yeong, W. Y. & Wiria, F. E. (2016). Laser and electron-beam powder-bed additive manufacturing of metallic implants: A review on processes, materials and designs. *Journal of Orthopaedic Research*, 34(3), 369-385. https://doi.org/10.1002/jor.23075

Skou, S. T., Roos, E. M., Laursen, M. B., Rathleff, M. S., Arendt-Nielsen, L., Simonsen, O. & Rasmussen, S. (2015). A randomized, controlled trial of total knee replacement. *New England Journal of Medicine*, 373(17), 1597-1606. https://doi.org/10.1056/NEJMoa1505467

Taniguchi, N., Fujibayashi, S., Takemoto, M., Sasaki, K., Otsuki, B., Nakamura, T., Matsushita, T., Kokubo, T. & Matsuda, S. (2016). Effect of pore size on bone ingrowth into porous titanium implants fabricated by additive manufacturing: an in vivo experiment. *Materials Science and Engineering: C*, 59, 690-701. https://doi.org/10.1016/j.msec.2015.10.069

Wang, J., Alotaibi, N. M., Ibrahim, G. M., Kulkarni, A. V. & Lozano, A. M. (2017). The Spectrum of Altmetrics in Neurosurgery: The Top 100 "Trending" Articles in Neurosurgical Journals. *World Neurosurg*, 103, 883-895.e881. https://doi.org/10.1016/j.wneu.2017.04.157

Wang, W. & Yeung, K. W. (2017). Bone grafts and biomaterials substitutes for bone defect repair: A review. *Bioactive materials*, 2(4), 224-247. https://doi.org/10.1016/j.bioactmat.2017.05.007

Wang, X., Xu, S., Zhou, S., Xu, W., Leary, M., Choong, P., Qian, M., Brandt, M. & Xie, Y. M. (2016). Topological design and additive manufacturing of porous metals for bone scaffolds and orthopaedic implants: A review. *Biomaterials*, 83, 127-141. https://doi.org/10.1016/j.biomaterials.2016.01.012

Wiggins, A. J., Grandhi, R. K., Schneider, D. K., Stanfield, D., Webster, K. E. & Myer, G. D. (2016). Risk of secondary injury in younger athletes after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *The American journal of Sports Medicine*, 44(7), 1861-1876. https://doi.org/10.1177/0363546515621554

Zhang, Y., Xu, J., Ruan, Y. C., Yu, M. K., O'Laughlin, M., Wise, H., Chen, D., Tian, L., Shi, D. & Wang, J. (2016). Implant-derived magnesium induces local neuronal production of

CGRP to improve bone-fracture healing in rats. *Nature Medicine*, 22(10), https://doi.org/1160-1169. 10.1038/nm.4162

Zhao, D., Witte, F., Lu, F., Wang, J., Li, J. & Qin, L. (2017). Current status on clinical applications of magnesium-based orthopaedic implants: A review from clinical translational perspective. *Biomaterials*, 112, 287-302. https://doi.org/10.1016/j.biomaterials.2016.10.017