Does altmetric score affect the impact factor of anatomy journals?

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SUMMARY

The impact of a scientific article is measured by the impact factor (IF) of the journal in which it was published and the number of citations. The real impact is causing delays as citations happen over time. The Altmetric score originated as a measure of the digital dissemination of a scientific article across multiple social platforms**.** Our study aims to determine whether the Altmetric scores are related to the journal impact factor and the number of citations in the anatomy literature. The top 10 most cited articles were determined for the 15 anatomy journals with the highest impact factor in 2014, 2017 and 2019. Citation counts and Altmetric scores were recorded for each article. The relationship between the Altmetric score and 2019, 2017 and 2014 citation numbers were evaluated. It was also evaluated in correlation with the 2020 impact factor. At the same time, it was determined whether the articles had anatomical content or not.

In 2014, Altmetric scores did not correlate with citation number (r = 0.368, P = 0.177) and journal impact factor (r = 0.43, P = 0.52). In 2017, there was significant positive correlation between Altmetric scores and citation number (r = 0.914, P = 0.000), as well as between Altmetric scores and journal impact factor (r = 0.038, P = 0.003). Also significant positive correlation between 2017 Altmetric scores and 2019 impact factor (r = 0.065, P = 0.021). This study is the first to link traditional bibliometric measurements with newer digital dispersion measurements for anatomy publications. The Altmetric score correlates only weakly with citation numbers in the anatomy literature. However, the increase in the number of citations or the impact factor of the journals in which articles on anatomy are published shows that anatomy studies can be effective.

Key words: Altmetric score – Social media – Anatomy – Impact factor

INTRODUCTION

In order to determine the quality, distribution and impact of scientific research, the number of article citations and the impact factor of the journal in which the article is published are traditionally used methods (Nocera et al., 2019). The ubiquity of the Internet and social media in our daily lives has brought information to the public in its dissemination. Social media platforms continue to expand how information is shared, distributed, encountered and responded to in society. Various platforms such as Twitter, Facebook, blogs, Reddit and others, and online video sharing offer new opportunities for academic medical researchers

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to expand their literature to the community (Priem et al., 2010). New bibliometric measurements using these platforms allow faster research dissemination and impact determination, unlike historical methods of citation count and journal impact factor calculations that may delay this process (Bornmann and Leydesdorff, 2014).

The extent of scientific research dissemination in the public sphere can be analyzed using the Altmetric attention score (AAS) (Elmor, 2018). AAS is the weighted number of all the research article's attention in the automatically calculated electronic media, including news sources and social media. It is a way of assessing the extent to which scientific research breakthroughs have spread to society. Its analysis provides an opportunity to gauge the public's relationship with a scientific field (Dagar and Falcone, 2021).

Recent research has analyzed the AAS of various medical and surgical subspecialties (Barakat et al., 2018; Patel et al., 2018; Nocera et al., 2019; Punia et al., 2019; Jia et al., 2020). A systematic review suggests that research studies' mentions of social media are associated with an increasing number of citations (Bardus et al., 2020). Similarly, a randomized controlled study found that tweeted articles received higher citations, with rates 9.5 times higher than articles randomized to the non-tweeted group (Luc et al., 2020; Hayon et al., 2019). This interest in the study of AAS in medicine reflects the reputation of a research study as a measure for assessing its impact on public access and academic impact.

To our knowledge, there are no previous studies in the anatomy literature comparing the relationships between traditional publication recognition bibliometry and Altmetric scores, including citation count and journal impact factor. This study aims to determine the correlation between these metrics to assess whether they are interchangeable measures of article influence and impact.

MATERIALS AND METHODS

We identified the 15 journals with the highest impact factor in Anatomy in 2014, 2017 (using Journal Citations Reports) (Clarivate, n.d.) (Clarivate, 2019. Journal citation report) and 2019 (using each journal website). While Journal Citation Reports utilizes the traditional impact factor to measure journal influence based on citable documents over two years, Scopus utilizes Citescore, which evaluates a 3-year citation window of all published document types. The results from searches the top 15 anatomy journals: *Human Brain Mapping, Frontiers in Neuroanatomy, Brain Topography, Brain Structure and Function, American Journal of Physical Anthropology, Journal of Anatomy, The Anatomical Record, Annals of Anatomy, Anatomical Sciences Education, American Journal of Surgical Pathology, Clinical Anatomy, Cell Tissues Organs, Journal of Histochemistry and Cytochemistry, American Journal of Human Biology, Anatomical Science International.*

All the original research articles published in these journals were extracted and tabulated. We used Dimensions (Digital Science & Research Solutions Inc.) to identify the AAS of included articles. We accessed this information to identify the top-10 most cited articles for 15 journals from January to December 2014. The same procedure was then used to identify the top-10 most cited articles from 2017 and 2019 for each of the journals above in order to account for changes in the Altmetric scoring system, shifts in the popularity and utilization of different social media platforms, and the overall advancement of the digital landscape of scientific research. The impact factor was assessed using Journal Citation Reports for each of the 15 journals in 2014, 2017 and 2019. The Altmetric score was recorded using the Altmetric bookmarklet for each of the 450 overall articles evaluated.

Statistics for this study were performed with SPSS V20. Kolmogorov–Smirnow test was used to control whether data were dispersed usually. Descriptive statistics were expressed as mean±SD for the continuous variables. Nonparametric analyses were applied, as the data were not normally distributed. Significant findings were interpreted using a predetermined P-value threshold of <.05. Mann Whitney U test was used to compare the articles according to their anatomy content. The correlation between the variables studied was determined using the

Spearman correlation coefficient (r), whereas the coefficient of determination (R2) was used to determine the proportion of variance in the data accounted for by the correlations discovered. This statistical analysis and methodological procedure were primarily derived from prior research that analyzed the correlation between the Altmetric score and citations in pediatric surgery and urology literature (Chang et al., 2019; Nocera et al., 2019).

RESULTS

Altmetric scores were recorded for the top 10 most-cited articles published in 2014 from each of the top 15 anatomy journals identified via Journal Citation Reports (Table 1). Hence, a total of 150 articles were analyzed from 2014. Citation count and journal impact factor showed a significant strong positive correlation in the 2014 cohort (r = 0.795, P <0.0001 for impact factor, Fig. 2). Altmetric scores were not associated with citation number for articles published in 2014 (r = 0.368, P = 0.177) and journal impact factor for manuscripts published in the same year (r = 0.032, P = 0.052; Fig. 1). This finding suggests that citation count and journal impact factor in the papers published in the 15 anatomy journals evaluated in 2014 are not strongly predicted by those articles' Altmetric scores.

The journals were also analyzed individually to determine a correlation coefficient between citation count and Altmetric score (Table 2). In 2014, only two journals out of the 15 analyzed had significant correlations between their articles' citation number and Altmetric scores. The journals with significant negative and positive associations between these variables included Anatomical Sciences Education (r = - 0.68, P = 0.02), American Journal of Surgical Pathology (r = 0.76 P = 0.01).

Altmetric scores were compared to citation count, and journal impact factor in 2017. Altmetric scores were significantly correlated with citation number for articles published in 2017 (r = 0.914, P = 0.000). Journal impact factor was also significantly correlated with Altmetric scores in the same group of articles evaluated from 2017 (r = 0.038, P = 0.003, Fig. 1). Citation count and journal impact factor showed a significant strong positive correlation in the 2017 cohort (r=0.724, P= 0.000. Fig. 2). The journals from 2017 were analyzed individually to determine a correlation coefficient between citation count and Altmetric score (Table 2). Only one of the 15 journals showed a significant correlation between the number of citations of their articles and the 2017 article Altmetric score. These journal with significant positive associations included Journal of Histochemistry and Cytochemistry (r = 0.67; P = 0.03).

Altmetric scores were compared to citation count, and journal impact factor in 2019. Altmetric scores were significant strong positive correlated with citation number for articles published in 2019 (r = 0.614, P = 0.000). Journal impact factor was also significantly correlated with Altmetric scores in the same group of articles evaluated from 2019 (r = 0.20, P = 0.01 Fig. 1). Citation count and journal impact factor showed a strong, positive correlation in the 2019 cohort (r=0.561, P= 0.000, Fig. 2). The journals from 2019 were analyzed individually to determine a correlation coefficient between citation count and Altmetric score (Table 2). No significant correlation was found in any of the journals between the number of citations of their articles and the 2019 article Altmetric score.

Comparisons between the Altmetric score and citation data in 2014, 2017 and 2019 vs journal impact factor in 2017, 2019 and 2020 were additionally performed. Altmetric score not associated with journal impact factor 2017 for articles published in 2014 (r=0.036, P = 0.43). Altmetric score significantly correlates with 2019 impact for articles published in 2017 (r= 0.65, P = 0.02). Altmetric score not associated with journal impact factor 2020 for articles published in 2019 (r= -0.011, P = 0.89, Fig. 1). In 2014 Citation count and journal impact factor in 2017 showed a significant strong positive correlation (r=0.728; P= 0.000). Journal impact factor in 2019 was also significantly correlated with citation count in the 2017 (r=0.657; P=0.000). Also journal impact factor in 2020 was significantly correlated with citation count in the 2019 (r=0.518; P=0.000, Fig. 2).

Table 1. Categorization of anatomy journal bibliometric and altmetric data.

Journal	Citations (Median [Range]) 2014	Altmetrics Score (Median [Range]) 2014	Journal Impact Factor (2014)	Citations (Median [Range]) (2017)	Altmetrics Score (Median [Range]) (2017)	Journal Impact Factor (2017)	Citations (Median [Range]) 2019	Altmetrics Score (Median [Range]) 2019	Journal Impact Factor (2019)	Journal Impact Factor (2020)
Human Brain Mapping	143.5 (104-350)	7 (0-365)	6.05	79 (60-498)	18.5 (9-323)	5.14	56.5 (42-86)	10 (5-66)	4.42	5.38
Frontiers in Neuroanatomy	60 (38-85)	3 (0-124)	3.18	37 (24-74)	2 (0-906)	3.37	19.5 (17-28)	5 (2-14)	3.29	3.85
Brain Topography	0 (0-59)	0 (0-5)	3.26	22 (12-119)	1 (0-24)	2.71	16.5 (10-123)	1 (0-144)	2.76	3.02
Brain Structure and Function	84.5 (62-151)	1 (0-11)	3.75	35 (30-59)	2 (1-36)	4.18	27 (22-42)	27 (0-43)	3.30	3.27
American Journal of Physical Anthropology	40 (27-77)	7.5 (0-169)	2.42	34 (23-56)	24 (2-2787)	2.96	16.5 (13-44)	25 (0-356)	2.41	2.35
Journal of Anatomy	45.5 (39-69)	11.5 (1-38)	2.43	24 (19-49)	4 (0-19)	2.61	32 (17-74)	6 (0-117)	2.03	2.61
The Anatomical Record	51.5 (33-68)	1.5 (0-76)	1.77	24 (18-30)	1 (1-50)	1.46	18 (17-45)	3.5 (0-950)	1.63	2.06
Annals of Anatomy	20.5 (13-38)	0.5 (0-111)	1.87	15 (11-33)	0 (0-19)	2.08	10.5 (9-45)	0 (0-7)	2.39	2.69
Anatomical Sciences Education	46 (33-83)	0 (0-5)	2.45	23 (16-123)	0 (0-33)	3.49	23.5 (19-44)	3.5 (1-41)	3.76	5.95
American Journal of Surgical Pathology	113.5 (90-172)	7.5 (4-50)	6.53	74 (56-168)	27.5 (3-214)	6.40	47 (42-67)	6.5 (1-35)	6.16	6.39
Clinical Anatomy	23 (20-38)	0.5 (0-6)	1.58	7 (12-26)	1 (0-3)	2.21	19 (15-62)	2.5 (0-20)	1.97	2.41
Cell Tissues Organs	21.5 (18-51)	0 (0-3)	2.42	13 (8-28)	0 (0-16)	1.43	7 (5-11)	0 (0-8)	2.06	2.48
Journal of Histochemistry and Cytochemistry	50.5 (35-200)	1.5 (0-7)	2.59	22.5 (13-56)	1.5 (0-13)	2.91	8.5 (7-77)	2.5 (1-23)	2.19	4.3
American Journal of Human Biology	55 (27-56)	5.5 (0-313)	1.99	35 (16-66)	6 (0-129)	1.70	19.5 (13-45)	14 (0-54)	1.56	1.93
Anatomical Science International	15.5 (11-20)	0 (0-6)	0.99	10 (6-32)	0 (0-1)	1.34	7 (6-18)	0 (0-3)	1.51	1.74

Comparisons between the Altmetric score and citation data in 2014, 2017, and 2019 were performed. From the same 15 anatomy journals selected for evaluation, a listing of the ten most cited articles in each journal in years (n = 450) was compiled. Altmetric scores and citation numbers for these articles were recorded. The cumulative citation count in 2017 was 5558 compared to the 8633 citations in 2014, representing a 35.6 % decrease. The cumulative citation count in 2019 was 3863 compared to the citations in 2017, representing a 21.5% decrease.

The cumulative Altmetric score in 2017 was 6330 compared to the 2135 cumulative total in 2014, representing a 133.7% increase. The cumulative Altmetric score in 2019 was 4247 compared to the Altmetric score in 2017, representing a 32.9% decrease. While the median value of the number of citations in 2017 was 43, 25 in 2014, this value was 19 in 2019. The median value of the Altmetric score in 2017 was 1 in 2014, 1.5 in 2017, and 4 in 2019.

According to the results of this comparison, we compared whether the first 15 articles of the

journals we included in the study were articles with anatomy content. While 70 of the articles in 2014 were content anatomy, 80 articles were not content anatomy. In 2017, 60 articles were content anatomy, 90 were not, and in 2019, 61 articles were content anatomy, and 89 were not. In comparing whether the first ten articles included in the study included anatomy in 2014, 2017 and 2019, there was a decrease in the correct anatomy content from 2014 to 2019.

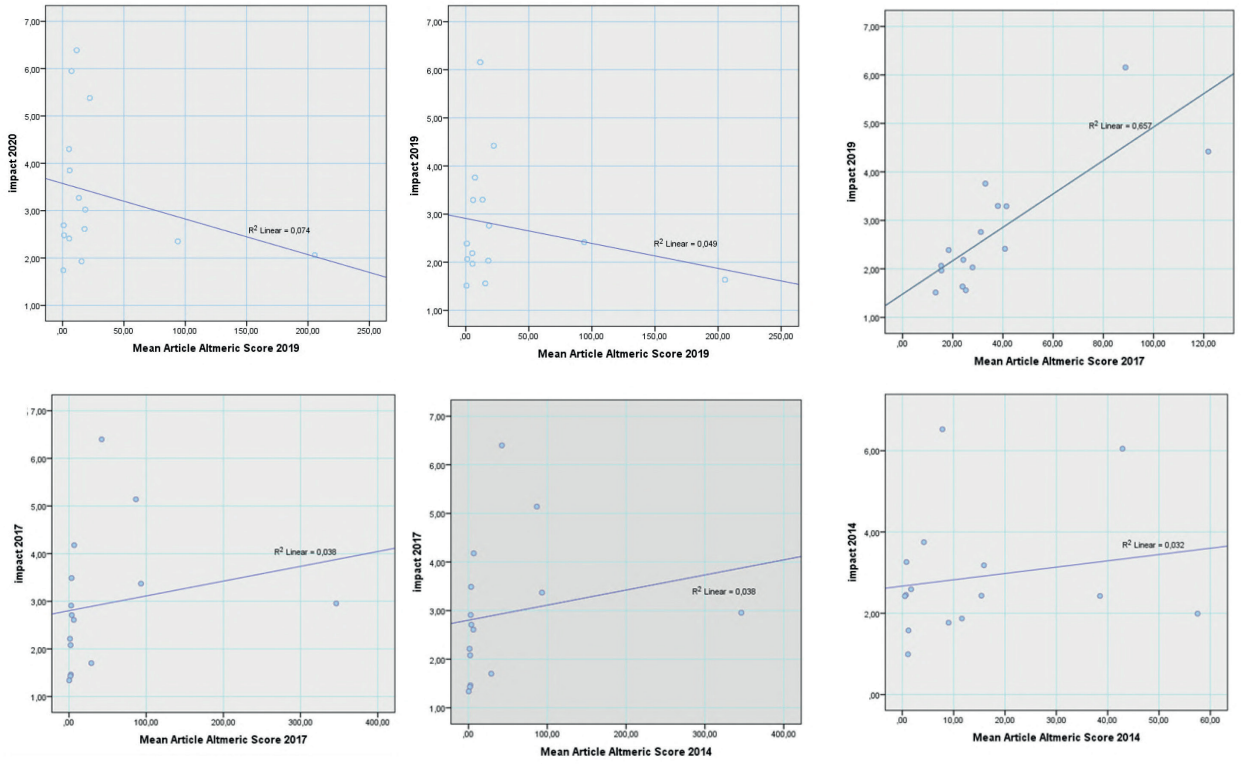

Fig. 1.- Comparisons between the Altmetric score and impact factor in 2014, 2017, 2019 and 2020.

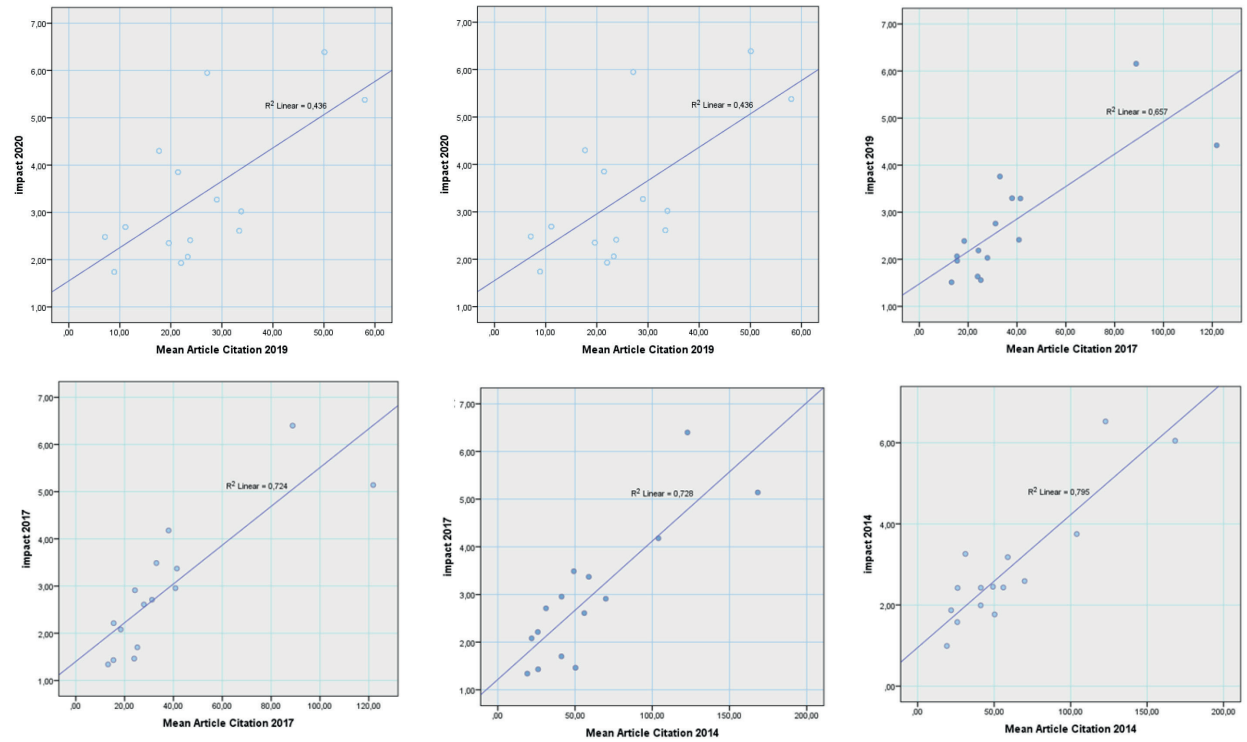

Fig. 2.- Comparisons between the citation and impact factor in 2014, 2017, 2019 and 2020.

Table 2. Summary of comparisons between bibliometrics and altmetrics for the journals of study in 2014, 2017 and 2019.

Journal	Correlation coefficient between number of citations and altmetric score (2014)	P value (2014)	Correlation coefficient between number of citations and altmetric score (2017)	P value (2017)	Correlation coefficient between number of citations and altmetric score (2019)	P value (2019)
Human Brain Mapping	0.43	0.21	0.04	0.90	-0.29	0.40
Frontiers in Neuroanatomy	0.21	0.55	-0.21	0.55	-0.45	0.18
Brain Topography	0.32	0.36	0.11	0.75	0.33	0.34
Brain Structure and Function	-0.09	0.76	-0.01	0.97	0.24	0.49
American Journal of Physical Anthropology	-0.07	0.84	-0.21	0.55	0.57	0.08
Journal of Anatomy	-0.16	0.65	0.03	0.91	-0.16	0.64
The Anatomical Record	-0.38	0.26	0.21	0.54	-0.02	0.95
Annals of Anatomy	0.00	0.98	-0.59	0.07	-0.32	0.36
Anatomical Sciences Education	-0.68	0.02*	0.52	0.11	0.23	0.52
American Journal of Surgical Pathology	0.76	0.01**	0.60	0.06	0.18	0.61
Clinical Anatomy	0.51	0.13	-0.38	0.27	0.59	0.07
Cell Tissues Organs	-0.06	0.85	-0.06	0.84	0.10	0.78
Journal of Histochemistry and Cytochemistry	0.24	0.50	0.67	0.03*	0.46	0.17
American Journal of Human Biology	0.29	0.41	0.03	0.93	0.60	0.06
Anatomical Science International	-0.19	0.58	0.22	0.52	-0.06	0.86

Correlation is significant at the *p <0.05; ** p <0.00

While there was no significant difference in comparing the anatomy content of the articles with the Altmetric score, article citations in 2014, a significant difference was found between the number of journal citations and impact factor for these years.

In the comparison made for 2017, there was no significant difference between journal citation and journal impact factor, but a significant difference was found between anatomy content in article citation and Altmetric score.

In the comparison made for 2019, a significant difference was found only between the number of journal citations and the anatomy content (Table 3).

When the articles in 2014 were examined, it was determined that the most cited articles for each of the 15 journals were the anatomy-based studies with morphometric measurements. In particular,

Table 3. Comparison of the anatomical content of the articles and the altmetric score, citation and impact factors.

Number of anatomy content articles (n) / year	Altmetric score 2014 (p)	Citation number of article 2014 (p)	İmpact factor 2014 (p)	Citation number of journal 2014 (p)	Altmetric score 2017(p)	Citation number of article 2017 (p)	İmpact factor 2017 (p)	Citation number of journal 2017 (p)	Altmetric score 2019 (p)	Citation number of article 2019 (p)	İmpact factor 2019 (p)	Citation number of journal 2019 (p)
N=70 yes N=80 no 2014	0.15	0.42	0.00**	0.01*	-	-	-	-	-	-	-	-
N=60 yes N=90 no 2017	-	-	-	-	0.00**	0.03*	0.28	0.08	-	-	-	-
N=61 yes N=89 no 2019	-	-	-	-	-	-	-	-	0.20	0.34	0.10	0.02*

Significant at the *p <0.05; ** p <0.00.

Simple box plot analysis of Altmeric score 2017.

it was determined that studies with anatomy related to a disease or syndrome received more citations, while gross anatomy studies did not receive as many citations. When the articles in 2017 and 2019 were evaluated according to their citations, it was determined that the articles less contained anatomy. At the same time, it was observed that the journals that published gross anatomy studies included studies with histological and genetic content in these years, and it was determined that the number of citations in the articles of these journals decreased. Again in these years, it was observed that the articles with the highest citations were generally those without gross anatomy but with anatomy content.

DISCUSSION

To our knowledge, this is the first study to provide an in-depth statistical analysis of the relationship between Altmetrics and traditional bibliometrics of this scale in the anatomy literature. A weak positive correlation was demonstrated between the Altmetric score and citation number in the 2014 and 2017 cohorts. While the 2014 cohort only demonstrated a significant correlation between journal impact factor and citation count, the 2017 cohort demonstrated a significant correlation between Altmetric score with citation count and journal impact factor 2017 and 2019. The significant correlation of the Altmetric score of 2017 to the 2019 impact factor suggests that it is due to the more effective use of social media in recent years. But no significant correlation of the Altmetric score of 2019 to the 2020 impact factor. This result may suggest that another criterion may be determinative instead of the Altmetric score.

The increasing influence and societal uptake of various social media forms influence how research is distributed and encountered. The influence of this technology is demonstrated in our evaluation of the total Altmetric score in both the 2014 and 2017 cohorts. The total Altmetric score among 150 articles in 2017 was over three times more than the total Altmetric score among the same number of articles in 2014.

Social media is now on the agenda in academic studies, and some studies may even become a periodic subject of social media. The increase in the Altmetric scores of the articles in 2017 compared to 2014 is that social media is used more frequently and covers almost every field. In 2019, the Altmetric scores of the articles were lower than in other years. However, the number of citations for 2019 is equally low. Here, the citation

and Altmetric score may change according to the elapsed time.

The most cited articles were targeted and included in the study without considering their Altmetric scores were 0 points. Although these articles were read in Mendeley, an Altmetric score has not yet been formed because they are not included in social media (Twitter, Facebook, news outlet, blog, etc.).

These studies are influenced by the content of the journals and the subject of the article. In 2017, there were articles with many citations but an Altmetric score of 0. According to the research results, in 2017, when the journals reached the highest Altmetric score, the journals and articles that scored 0 were mostly anatomy education, tissue studies and model studies. This result can be interpreted as the fact that the public finds this information complex in the studies above and that this information is at a very advanced level, which is more of an interest to the academic community.

According to other studies on this subject, we can state that the journals used in our study are distributed homogeneously, because the journals in this study were not only gross anatomy but also journals covering the branches of neuroscience, radiology, anatomy education, microscopic anatomy and clinical anatomy. When we looked at the journals one by one in the study results, we saw that the articles of journals dealing with neuroscience had a higher Altmetric score. Analysis has led us to comment that neuroscience is more up-to-date and more remarkable, and therefore more spread on social media. The least Altmetric score was seen in educational journals. It was found that this journal showed a significant negative correlation between the Altmetric score and the number of citations in 2014. Our study showed us that articles on anatomy education did not attract much attention on social media.

Of the 15 journals evaluated, only 2 in 2014 and 1 in 2017 demonstrated significant correlations when analyzed individually. This finding may reflect differences in the methodologies behind Altmetrics and traditional bibliometrics or different approaches to article dissemination among individual journal authors and subscribers. Results suggest that Altmetrics alone may not be a good surrogate for article citations.

We can think that the decrease in citation numbers of the articles that have been cited the most in journals over the years may be due to the fact that the articles contain less anatomy. In 2014, when the most citations were received, the studies were usually human studies with anatomy content, and the lowest citation articles were histological and genetic studies. In line with these results, anatomy comes to the fore. In the same way, the same interpretation can be made for other years.

The articles with the highest Altmetric scores are mostly neuroscience-related. When we look at the neuroscience articles in general, it is also remarkable that the neuroscience articles with the anatomy content have high Altmetric scores. The common point of the two articles with the highest Altmetric scores belonging to two different journals in the study is that they contain new information about species (humans and carnivores). Apart from this, the fact that the articles evaluated within the scope of the study have higher Altmetric scores in studies containing human anatomy can be interpreted as increasing the effect when the studies are based on anatomy.

In this case, we can argue that the high number of articles with anatomy content in the top 15 most cited journals in 2014, when it was the highest impact factor, affected the journal citation and impact factor. In 2017 and 2019, the Altmetric score and citation number of articles did not affect the journal, and the number of citations and impact factors of the journals decreased with the fact that the top 15 models included fewer anatomy articles in their content. As a result, we can say that when journals generally publish studies with anatomy content, they are advantageous in terms of impact factor and number of citations.

In 2019 found that the Altmetric score was generally higher in articles where morphometric studies were paired with clinical findings: this and similar histological, genetic, pathological. Gross anatomy studies alone did not have the same effect in the evaluated articles. The fact that the studies had low Altmetric scores can be

interpreted as these issues are more of interest to researchers and have effectiveness in scientific platforms.

Our study has notable limitations. Our evaluation of each journal included the top-10 most cited articles. However, although some articles had fewer citations and a higher Altmetric score than the most cited article, they were omitted because they did not comply with the study method. The articles included in the study; Given that they represent a small minority of published research papers, it should be compared and discussed with further studies to assess whether these results can be generalized to studies with less visibility and impact. Despite the limitations above, our study is the first of its kind in anatomy. After that, studies in anatomy journals can be done on which subjects and with which methods the Altmetric score will be increased.

Today, the spread of research and its reach to more readers have increased with the Internet. For this reason, it brings to mind the question of whether actively used social media can affect the impact factors of studies. The question arises whether the effectiveness of a study should be measured by sharing it too much on social media and reaching more people, or whether it should be continued with the classical methods we know. Considering that social media does not have qualified criteria in evaluating studies, can it be accepted as a reliable and accurate representation method of the effect of the Altmetric score? Or which social media platforms will be considered eligible for this assessment? Therefore, further research is needed to evaluate the relationships between Altmetrics and traditional bibliometric measures to elucidate the relevance of Altmetrics in research analytics (O'Connor et al., 2017).

CONCLUSION

The Altmetric scoring system provides a more inclusive and rapid measurement of research impact than traditional metrics. However, this modernized system currently lacks data and large-scale studies to replace citation count and journal impact factor as the sole measure of article dissemination. More research is needed to evaluate the relationships between Altmetrics and traditional bibliometric measures to elucidate Altmetrics' relevance in research analytics.

According to the study results, an increase in the impact factor or the number of citations of the journals that publish the articles containing anatomy may facilitate the acceptance of anatomy studies by the journals. Future studies should help understand the impact of social media's relationship with anatomy research and its tools to disseminate new information.

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