Examining the Correlation Between Altmetric Score and Citations in the Urology Literature

Alexander P. Nocera[#], Carter J. Boyd[#], Hunter Boudreau, Ornin Hakim, and Soroush Rais-Bahrami

OBJECTIVE To determine if article Altmetric scores correlate with journal impact factor and citation count in the urologic literature.

METHODS We identified the top 10 most-cited articles for the 15 urology journals with the highest impact factor in 2013 and 2016. Citation count and Altmetric scores were recorded for each of the articles. The journal impact factor and date of Twitter account development were recorded for each of the journals. The variables were analyzed in Microsoft excel using Pearson's correlation testing.

RESULTS A total of 300 articles were analyzed. In 2013, Altmetric scores and citation number showed a significant positive correlation ($r = 0.164$, $P = .045$), although Altmetric scores did not correlate with journal impact factor ($r = 0.005$, $P = .957$). In 2016, there was significant positive correlation between Altmetric scores and citation number ($r = 0.268$, $P = .0009$), as well as between Altmetric scores and journal impact factor ($r = 0.201$, $P = .014$). The total citation count decreased from 15,235 in 2013 to 8622 in 2016 while the total Altmetric score increased from 1135 in 2013 to 2563 in 2016. Older Twitter accounts were not associated with increasing correlations between Altmetric score and bibliometrics in either 2013 ($r = 0.221$, $P = .54$) or 2016 ($r = 0.083$, $P = .819$).

CONCLUSION At this point in time, Altmetric score is only weakly correlated with citation counts in the urology literature. Altmetrics and traditional bibliometrics should be viewed as complements to one another rather than surrogates when determining research dissemination and impact. UROLOGY 134: 45–50, 2019. © 2019 Elsevier Inc.

The traditional metrics for determining the quality, distribution, and impact of scientific research have largely centered around article citation number and the impact factor of the journal in which the article was published.[1] With the continual advancement of digital technology and the societal uptake of various social media platforms, new metrics have arisen in order to more comprehensively assess the dissemination and utilization of published research.

Social media platforms have continued to expand the way in which society can distribute, encounter, and respond to shared information. Various platforms such as Twitter, Facebook, blogs, Reddit, and online video sharing among others have presented academic medical researchers with new opportunities to expand the coverage of their literature to society. New bibliometric measures that utilize these platforms have allowed research dissemination and impact to be more immediately determined as opposed to the historical methods of citation number and journal impact factor calculations which can delay this process.[2,3] The urology literature has begun to investigate the utilization of social media outlets and their impact on article dissemination by evaluating these new bibliometric measures.[4]

In 2010, Altmetric created a scoring system as a complement to traditional bibliometrics.[5] This system tracks the online media presence of an article by measuring and compiling the mentions an article receives across various media outlets including Twitter, Facebook, blogs, policy sources, news outlets, Wikipedia, Reddit, online videos, patents, Google+, and research highlight platforms.[6,7] Each mention that an individual article receives on one of these platforms is weighted using an automated algorithm that takes into account the source and author of each mention among other factors. The article's final Altmetric score reflects the summation of these weighted mentions.[7] To our knowledge, there are no prior studies comparing the associations between traditional bibliometrics of publication recognition

[#] *Equal contribution as primary authors.*

Funding: *None.*

Financial Disclosure: *Soroush Rais-Bahrami serves as a consultant to Philips/InVivo Corp, Genomic Health Inc, Blue Earth Diagnostics, and Bayer Healthcare.*

From the School of Medicine, University of Alabama at Birmingham, Birmingham, AL; the Department of Urology, University of Alabama at Birmingham, Birmingham, AL; the Department of Radiology, University of Alabama at Birmingham, Birmingham, AL; and the O'Neal Comprehensive Cancer Center at UAB, University of Alabama at Birmingham, Birmingham, AL

Address correspondence to: Soroush Rais-Bahrami, M.D., Department of Urology, University of Alabama at Birmingham, Faculty Office Tower 1107, 510 20th Street South, Birmingham, AL 35249. E-mail: sraisbahrami@uabmc.edu

Submitted: June 21, 2019, accepted (with revisions): September 16, 2019

including citation count and journal impact factor with Altmetric scores across the urologic literature. Our objective in this study is to determine the correlation between these metrics in order to assess whether they are interchangeable measures of article influence and impact. We hypothesize that Altmetric scores will not be tightly correlated with citation counts from 2013 articles, but 2016 articles will show a stronger correlation as social media has become more widely popularized in the professional arena.

METHODS

The top 15 urologic journals were identified via Elsevier's Citescore from the Scopus database using "Urology" as the search category.[8] ISI Web of Knowledge Journal Citation Reports was searched using "Urology and Nephrology" as the search category.[9] Journals with a primary nephrology focus were manually excluded. While Journal Citation Reports utilizes traditional impact factor as a measure of journal influence based on citable documents over a 2-year period, Scopus utilizes Citescore, which evaluates a 3-year citation window of all published document types. To increase the fidelity of our journal selection based on true impact, the results from both searches were merged in order to identify the top journals: *European Urology*, *Prostate Cancer and Prostatic Diseases*, *Nature Reviews Urology*, *BJU International*, *Prostate*, *Urologic Oncology: Seminars and Original Investigations*, *Journal of Urology*, *Journal of Sexual Medicine*, *Neurourology and Urodynamics*, *Journal of Endourology*, *Urology*, *World Journal of Urology*, *Current Urology Reports*, *Clinical Genitourinary Cancer*, and *Asian Journal of Andrology*. Elsevier's Scopus was again used to identify the top 10 most-cited articles for each of the 15 journals from January to December 2013. The same procedure was then used to identify the top 10 most-cited articles from 2016 for each of the aforementioned journals 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. Since both Scopus and Journal Citation Reports evaluate article influence based on citation count, and Scopus provides a broader and more inclusive list of articles, the data from Scopus alone was used to determine the top articles for each journal. The impact factor was assessed using Journal Citation Reports for each of the 15 journals in both 2013 and 2016. The Altmetric score was recorded using the Altmetric bookmarklet for each of the 300 overall articles evaluated.[10] Each of the 15 journals was then assessed for having a dedicated Twitter profile, and the date of Twitter account development was recorded if applicable and available. Statistics for this study were performed with Microsoft Excel, and significant findings were interpreted using a predetermined P value threshold of <.05. The correlation between the variables studied was determined using Pearson's correlation coefficient (r) whereas the coefficient of determination (R^2) was used to determine the proportion of variance in the data that was accounted for by the correlations discovered. This statistical analysis and methodological procedure were largely derived from prior research that analyzed the correlation between Altmetric score and citations in pediatric surgery literature.[11]

RESULTS

Altmetric scores were recorded for the top 10 most-cited articles published in 2013 from each of the top 15 urologic journals as identified via a merger of Elsevier's Citescore and Journal Citation Reports (Table 1). Hence, a total of 150 articles were analyzed from 2013. The cumulative total number of citations for all of the articles was 15,235, whereas the cumulative total Altmetric score for all of the articles was 1135. The number of citations for each individual article ranged from 22 to 830 with a median of 62.5. The Altmetric scores for each individual article ranged from 0 to 144 with a median of 2. Ten of the 15 identified journals had established Twitter accounts at the time of analysis (Table 1). Citation count and journal impact factor showed a significant strong positive correlation in the 2013 cohort ($r = 0.757$, $P < .0001$). Altmetric scores were significantly positively correlated with citation number for articles published in 2013 ($r = 0.164$, $P = .045$), but Altmetric scores were not associated with journal impact factor for manuscripts published in the same year ($r = 0.005$, $P = .957$; Fig. 1A and B). R^2 was minimal for both correlations ($R^2 = 0.027$ for citations, $R^2 < 0.0001$ for impact factor). This finding suggests that citation count and journal impact factor in the papers published in the 15 urology journals evaluated in 2013 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 2013, there were only 4 journals out of the 15 analyzed that had significant correlations between their articles' citation number and article Altmetric scores. The journals with significant positive associations between these variables included the *Journal of Urology* ($r = 0.755$, $P = .011$), *Journal of Endourology* ($r = 0.808$. $P = .005$), *Urology* ($r = 0.658$, $P = .043$), and *Clinical Genitourinary Cancer* ($r = 0.872$, $P = .0009$).

Comparisons between the Altmetric score and citation data in 2013 vs 2016 were additionally performed. From the same 15 urology journals selected for evaluation, a listing of the 10 most-cited articles in each journal in 2016 ($n = 150$) was compiled. Altmetric scores and citation numbers for these articles were recorded. The cumulative citation count in 2016 was 8622 compared to the 15,235 citations in 2013, representing a 43.4% decrease. The cumulative Altmetric score in 2016 was 2563 compared to the 1135 cumulative total in 2013, representing a 125.8% increase. The median number of citations in 2016 was 30 compared to 62.5 in 2013, whereas the median Altmetric score in 2016 was 3 compared to 2 in 2013, demonstrating a similar pattern as total number of citations and Altmetric scores over the interval change evaluated.

Altmetric scores were compared to citation count and journal impact factor in 2016. Altmetric scores were significantly correlated with citation number for articles published in 2016 ($r = 0.268$, $P = .0009$). Journal impact factor was also significantly associated with Altmetric scores in the same group of articles evaluated from 2016 ($r = 0.201$, $P = .014$). R^2 was 0.072 for citation count and 0.040 for journal impact factor in 2016. The journals from 2016 were analyzed individually to determine a correlation coefficient between citation count and Altmetric score (Table 2). Six of the 15 journals demonstrated significant correlations between their articles' citation number and article Altmetric score in 2016. These journals with significant positive associations included *Prostate Cancer and Prostatic Diseases* ($r = 0.696$, $P = .025$), *Nature Reviews Urology* ($r = 0.951$, $p<.0001$), *BJU International* ($r = 0.926$, $P = .0001$), *Journal of Endourology* ($r = 0.789$, $P = .007$), *Urology* ($r = 0.727$, $P = .017$), and *World Journal of Urology* ($r = 0.743$, $P = .014$).

Of the 15 urologic journals selected, 10 had established Twitter accounts at the time of this study. The average age of the Twitter accounts among the 10 applicable journals was approximately

Table 1. Categorization of urology journal bibliometric and Altmetric data

Journal	Citations (Median [Range])	Altmetrics Score (Median [Range])	Journal Impact Factor (2013)	Journal Impact Factor (2016)	Age of Twitter Account (y)
European Urology	426.6 [244-830]	7.8 [0-18]	12.48	16.27	8.2
Prostate Cancer and Prostatic Diseases	62.5 [44-91]	8.2 [0-30]	2.83	3.72	5.1
Nature Reviews Urology	72.9 [55-135]	67.3 [0-130]	4.52	7.74	7.6
BJU International	123.4 [70-295]	9 [0-22]	3.13	4.44	9.8
Prostate	82.4 [60-143]	1.9 [0-10]	3.57	3.82	n/a
Urologic Oncology: Seminars and Original Investigations	69.2 [53-114]	1.5 [0-6]	3.36	3.67	n/a
Journal of Urology	223.4 [163-532]	21 [2-65]	3.75	5.16	8.0
Journal of Sexual Medicine	100.2 [65-181]	20 [0-101]	3.15	2.98	5.0
Neurourology and Urodynamics	47.6 [31-104]	3.7 [0-10]	2.46	3.56	7.8
Journal of Endourology	45.2 [29-97]	4.9 [0-33]	2.10	2.27	5.8
Urology	93.9 [56-149]	3.3 [0-8]	2.13	2.31	4.2
World Journal of Urology	42 [35-54]	0.7 [0-3]	3.42	2.74	3.2
Current Urology Reports	31.2 [22-51]	2 [0-6]	n/a	2.12	n/a
Clinical Genitourinary Cancer	54 [38-105]	1.3 [0-12]	1.69	2.54	n/a
Asian Journal of Andrology	49 [38-830]	25.4 [0-144]	2.53	2.10	n/a

6.5 years. The oldest Twitter account belonged to *BJU International* (established in 2009), whereas the *World Journal of Urology* had the youngest Twitter account (established in 2016). The 5 journals that did not have an established Twitter account were as follows: *Prostate*, *Urologic Oncology: Seminars and Original Investigations*, *Current Urology Reports*, *Clinical Genitourinary Cancer*, and *Asian Journal of Andrology*.

Longer standing journal Twitter accounts were not significantly associated with increasing correlations between Altmetric score and bibliometrics based upon the highest cited articles published in both years evaluated when the journals were assessed individually: 2013 ($r = 0.221$, $P = .54$) and 2016 ($r = 0.083$, $P = .819$; Fig. 2). Analysis of the components contributing to the Altmetric score in 2013 demonstrated that Twitter, Facebook, and news outlets were the top 3 mediums in which articles were shared. In 2016, Twitter remained the most utilized medium. However, news outlets surpassed Facebook for the second most mentions and publication exposure (Supplementary

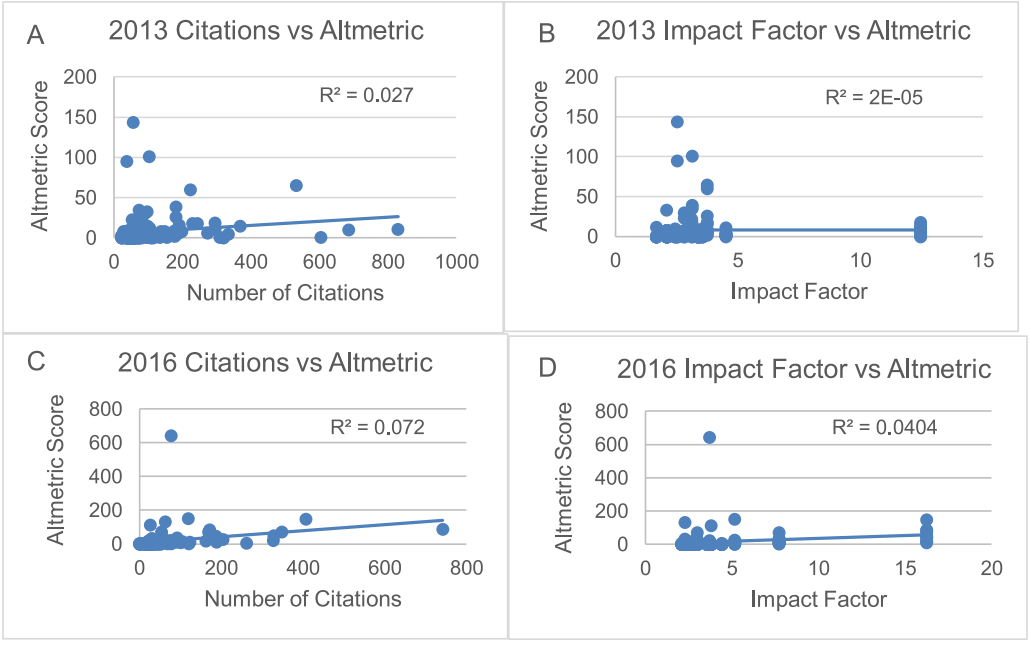

Figure 1. Altmetrics comparisons with citation count and journal impact factor by year. **(A)** Altmetric significantly correlates with citation count for articles published in 2013 ($P = .045$). **(B)** Altmetric not associated with journal impact factor for articles published in 2013 ($P = .96$). **(C)** Altmetric significantly correlates with citation count for articles published in 2016 ($P = .0009$). **(D)** Altmetric significantly correlates with journal impact factor for articles published in 2016 ($P = .014$). (Color version available online.)

Table 2. Summary of journal Twitter accounts and comparisons between bibliometrics and Altmetrics for the journals of study in 2013 and 2016

Journal	Year Twitter Created	Correlation Coefficient Between Number of Citations and Altmetric Score (2013)	*P* Value (2013)	Correlation Coefficient Between Number of Citations and Altmetric Score (2016)	*P* Value (2016)
European Urology	2011	0.01	.98	0.49	.15
Prostate Cancer and Prostatic Diseases	2014	0.38	.28	0.67	.03
Nature Reviews Urology	2011	−0.12	.74	0.95	<.0001
BJU International	2009	0.32	.37	0.93	.0001
Prostate	n/a	0.17	.64	0.11	.77
Urologic Oncology: Seminars and Original Investigations	n/a	−0.12	.74	0.36	.31
Journal of Urology	2011	0.76	.01	0.04	.91
Journal of Sexual Medicine	2014	0.22	.54	0.17	.65
Neurourology and Urodynamics	2011	0.44	.20	0.42	.23
Journal of Endourology	2013	0.81	.005	0.79	.01
Urology	2015	0.65	.04	0.73	.02
World Journal of Urology	2016	−0.60	.07	0.74	.01
Current Urology Reports	n/a	0.01	.98	0.10	.78
Clinical Genitourinary Cancer	n/a	0.87	.001	0.27	.45
Asian Journal of Andrology	n/a	0.01	.97	0.43	.22

Table 1). Twitter in both years was by far the most utilized medium for research dissemination with 539% more mentions than the second utilized medium in 2013 and 878% more mentions than the second utilized medium in 2016. From 2013 to 2016, Twitter (307%), Facebook (70.6%), news outlets (188%), Google+ (600%), and research highlight platforms (13.3%) saw increases in mentions. By contrast, blog (41.2%), policy source (54.5%), Wikipedia (31.3%), video (85.7%), and patent (37.5%) mentions were decreased in 2016 compared to 2013 (Supplementary Table 1).

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 urologic literature. There was a weak positive correlation demonstrated between Altmetric score and citation number in both the 2013 and 2016 cohorts. While the 2013 cohort only demonstrated a significant correlation between Altmetric score and citation count, the 2016 cohort demonstrated a significant correlation between Altmetric score with both citation count as well as journal impact factor. However, the minimal coefficients of determination suggest that Altmetrics and traditional bibliometrics should be utilized complementarily rather than interchangeably when determining the overall influence, distribution, and impact of urologic publications.

Of the 15 journals evaluated, only 4 in 2013 and 6 in 2016 demonstrated positive 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. Although Twitter was by far the most utilized medium out of the sources considered in the Altmetric algorithm, the age of a journal's Twitter account was not associated with

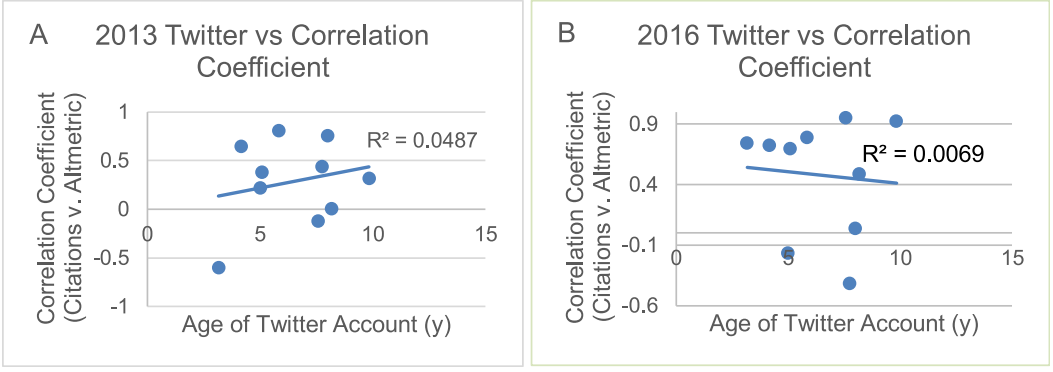

Figure 2. Correlation of Twitter account age and the correlation coefficients between citation count and Altmetric score for the journals. Older Twitter accounts were not associated with increased correlation between Altmetric score and bibliometric factors for the urology journals in 2013 (**A**, *P* = .54) or 2016 (**B**, *P* = .82). (Color version available online.)

increasing correlations between the various metrics in either the 2013 or 2016 cohort. This again suggests that Altmetrics alone may not be a sufficient surrogate for article citations.

Both Altmetrics and traditional bibliometric measures provide quantitative insight into research dissemination and impact. This provides a more standardized method of comparing article influence across medical literature. However, a major benefit of Altmetrics is the velocity at which an article's impact can be measured. Prior research has demonstrated that it can take multiple years for an article to accrue a stabilizing number of citations.[2,3] The evolution of digital technology and data sharing has placed increasing importance on the ability to quickly evaluate research influence with Altmetrics. When used in conjunction with traditional metrics, Altmetric scores assist in fully illuminating the societal reach of published literature. Prior research has demonstrated this complementary function of Altmetrics and traditional bibliometrics with results similar to those discussed in this study.[11,12]

The increasing influence and societal uptake of various social media forms continues to influence how research is distributed and encountered. The influence of this technology is demonstrated in our evaluation of total Altmetric score in both the 2013 and 2016 cohorts. The total Altmetric score among 150 articles in 2016 was over two times more than the total Altmetric score among the same number of articles in 2013. Furthermore, the media forms contributing most to an article's score varied as well. While Twitter dominated the social media landscape in both cohorts, news outlets surpassed Facebook for the second most mentions in 2016 compared to 2013. These findings could suggest continued evolution in the utilization of these media outlets, shifts in societal uptake of certain platforms, or differences in the consumer characteristics of each outlet. Although our study did not demonstrate increasing correlation between metrics among journals with long-standing Twitter accounts, prior studies have demonstrated correlations between Twitter activity and citations.[11-13] Our findings could be limited, however, in that our analysis was based on Twitter age rather than Twitter activity.

Our study also has other notable limitations. First, our evaluation only involved the top 15 urologic journals as defined by 2 publicly available rating systems based upon conventional measures of impact. It is unknown whether a larger sample of journals or journals of different urological topics would produce similar results. Additionally, peer-reviewed urologic publications in journals outside of the field would not be captured by this analysis although many of these may be impactful in more multispecialty or general medical journals. Second, our evaluation of each journal included the top 10 most-cited articles. Given that this sample represents the small minority of published research articles, it is difficult to assess whether these results can be generalized to research with less visibility and impact, again measured by a classic, conventional criteria of impact: citation number. Third, we analyzed correlations in 2 cohorts that were separated by 3 years. It is unclear if the correlations between metrics would be stronger or weaker at different time intervals between cohorts. Lastly, due to Twitter's dominance in the area of academia, we chose to only evaluate Twitter's influence on metric correlation rather than the other highly utilized media outlets. The aforementioned distinction between Twitter age and Twitter activity may undermine our use of Twitter as a surrogate for the attention an article receives online.

The advent of alternative methodologies to evaluate research dissemination instigates questions regarding the objectivity and consistency of using social media as a proxy for article impact. Each social media platform drastically differs in its audience, influence, and user interface. Furthermore, social media platforms mostly lack rigorous review criteria that establish the legitimacy of the data that is posted. This calls into question whether Altmetrics is a reliable and accurate representation of research influence.[11,14] More research is needed to evaluate the relationships between Altmetrics and conventional bibliometric measures in order to elucidate the relevance of Altmetrics in research analytics.

CONCLUSION

The Altmetric scoring system provides a more inclusive and immediate measure of research impact relative to traditional metrics. This modernized system, however, currently lacks the data and large-scale studies necessary to replace citation number and journal impact factor as a sole metric of article dissemination. What is known is that research dissemination seems to be influenced by social media. Although the degree and reasoning behind this influence remains debated, these findings suggest that Altmetrics and traditional bibliometrics should be used complementarily to provide a comprehensive view of the impact of research articles. The evaluation and utilization of Altmetrics will most likely continue to increase in frequency and significance as digital technology advances and the widespread use of social media in research progresses.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2019.09.014.

References

1. Durieux V, Gevenois P. Bibliometric indicators: quality measurements of scientific publication. *Radiology*. 2010;255:342–351.
2. Bornmann L, Leydesdorff L. Scientometrics in a changing research landscape: bibliometrics has become an integral part of research quality evaluation and has been changing the practice of research. *EMBO Rep*. 2014;15:1228–1232.
3. Wang J. Citation time window choice for research impact evaluation. *Scientometrics*. 2012;94:851–872.
4. Boyd C, Gentry Z, Martin K, Rais-Bahrami S. Factors associated with the highest and lowest cited research articles in urology journals. *Urology*. 2019;124:23–27.

5. Altmetric. Altmetric website. https://www.altmetric.com. Accessed June, 2019.
6. Priem J TD, Groth P, Neylon C. *Altmetrics: A Manifesto*. Altmetrics; 2010. Available at: http://altmetrics.org/manifesto. Accessed June, 2019.
7. Elmore S. The altmetric attention score: what does it mean and why should I care? *Toxicol Pathol*. 2018;46:252–255.
8. Scopus Sources, Elsevier. Available at: https://www.scopus.com/sources. Accessed June, 2019.
9. Journal Citation Reports, Clarivate Analytics. Available at: https://incites.clarivate.com. Accessed June, 2019.
10. Altmetric Bookmarklet. Available at: https://www.altmetric.com/products/free-tools/bookmarklet. Accessed June, 2019.
11. Chang J, Desai N, Gosain A. Correlation between altmetric score and citations in pediatric surgery core journals. *J Surg Res*. 2019;243:52–58.
12. Amath A, Ambacher K, Leddy J, Wood T, Ramnanan C. Comparing alternative and traditional dissemination metrics in medical education. *Med Educ*. 2017;51:935–941.
13. Hayon S, Tripathi H, Stormont I, Dunne M, Naslund M, Siddiqui M. Twitter mentions and academic citations in the urologic literature. *Urology*. 2019;123:28–33.
14. O'Connor E, Nason G, O'Kelly F, Manecksha R, Loeb S. Newsworthiness vs scientific impact: are the most highly cited urology papers the most widely disseminated in the media? *BJU Int*. 2017;120:441–454.