



Factors Associated With the Highest and Lowest Cited Research Articles in Urology Journals

Carter J. Boyd, Zachary L. Gentry, Kimberly D. Martin, and Soroush Rais-Bahrami

OBJECTIVE	To determine what factors of published urology research articles are associated with future citations.
METHODS	We identified all primary research articles published between 1997 and 2007 in <i>Journal of Urology</i> , <i>British Journal of Urology International</i> , <i>Urology</i> , and <i>European Urology</i> . Only 50 articles in this period had accrued 0 or 1 citation in a 10-year period following publication. We compared the characteristics of the articles in the low citation cohort to the 50 articles with the highest number of citations from the same journals and time period. Student's <i>t</i> tests, Wilcoxon rank-sum tests, chi-squared tests, and Fisher's exact tests were used to analyze the data with predetermined level of significance set to $P < .05$.
RESULTS	There were many significant differences between the 2 cohorts. When compared to the cohort of articles with 0 or 1 citation, highly cited articles were significantly more likely to be a clinical study, multi-institutional and multinational effort, and related to the field of urologic oncology. They were also significantly more likely to have a larger sample size, a statistically significant primary finding, more authors, more references, and more tables, as well as longer title, abstract, and overall manuscript word counts.
CONCLUSION	Very few articles published in the major urology journals accrued 0 or 1 citation over a 10-year period. This suggests that the vast majority of articles selected for publication are used for further future research. Nevertheless, there were distinct differences between the 2 cohorts, showing that certain factors are associated with articles being cited more frequently. UROLOGY 124: 23–27, 2019. © 2018 Elsevier Inc.

Medical research is the cornerstone of furthering medical knowledge, discovering new treatments, and improving the lives of patients. This requires a significant effort and expenditure of resources on the part of academic institutions, as well as their faculty and staff.¹⁻³ While all medical research is inherently valuable and important as contributions to the known body of shared knowledge, it can often be hard to quantify the impact of individual publications. Poorly written manuscripts, inappropriately designed experiments, and a host of other problems could potentially cause meaningful research to be disregarded or overlooked.

The accrual of citations is a metric often used to assess the importance of an article. While this method is imperfect, the use of an article to support subsequent research suggests that its findings influenced future investigators and how they view the advancements in their field.⁴

Efforts to quantify what makes research more impactful have been carried out in other fields such as radiology and cardiology, but this effort has not been as diligently pursued thus far in the urology literature.^{1,5} Because research requires immense effort and resources, determining factors associated with increased numbers of citations will help guide future authors, publishers, and readers in both crafting and interpreting research studies and articles.

Conflicts of Interest: None.

Funding: This study was funded in part by the National Center for Advancing Translational Sciences of the National Institutes of Health under award number UL1TR001417.

From the School of Medicine, University of Alabama at Birmingham, Birmingham, AL; the Department of Epidemiology, University of Alabama at Birmingham, Birmingham, AL; the Department of Urology, University of Alabama at Birmingham, Birmingham, AL; and the Department of Radiology, 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: sraibahrami@uabmc.edu

Submitted: September 10, 2018, accepted (with revisions): November 27, 2018

METHODS

We identified all primary research articles published between 1997 and 2007 in *Journal of Urology* (JU), *British Journal of Urology International* (BJUI), *Urology*, and *European Urology* (EU) employing the advanced PubMed search tool.⁶ Only articles with a 4-part abstract were included in the study. We excluded other types of articles or published materials, including review articles, editorials, case reports, guideline statements, and errata.⁷ We utilized the generated list of PubMed identification numbers to analyze the

articles for the total number of citations using iCite, a resource from the National Institute of Health.⁸

From this analysis, the articles that had accrued 0 or 1 citation in a 10-year period following publication in the 4 selected journals were reviewed. There were a total of 50 articles that had accrued 0 or 1 citations, and these articles constituted the low citation cohort of articles. An identical number of articles with the highest number of citations in these same 4 journals were also retrieved.

Both cohorts of articles were independently reviewed by 2 investigators for each of the publication characteristics assessed and subsequently discussed for any article with discrepancies in characteristics noted during primary data extraction to determine a consensus determination. Factors that were reviewed were based on a similar study in the radiology literature with the addition of several urology specific categories.¹ Information concerning the authorship and institutional affiliations was based on bibliographic information listed in the article bylines.

Authorship was classified for each article by recording the number of authors, country affiliation of the first author (USA vs non-USA), presence of a urologist author, presence of nonurologist authors, number of nonurology disciplines represented, number of institutions involved (single vs multi-institutional), and number of countries represented (single vs international). Other basic article demographic information was collected including the journal of publication, a reported source of funding, any stated conflicts of interest, and the urology fellowship that the research best aligned with (endourology; oncology; pediatric; men's health, including BPH, and erectile dysfunction; female/urodynamics/reconstruction; or other).

Articles were structurally characterized by recording the number of words in the title, presence of punctuation in the title (question mark, period, semicolon, hyphen, comma, colon), number of words in the abstract, number of words in the manuscript (excluding any appendixes), number of manuscript pages, number of tables, number of figures, and number of references. Finally, articles were characterized based on the presence of a statistically significant result reported in the abstract, the presence of a statistically significant result reported in the manuscript, study type (clinical vs nonclinical), study design (retrospective vs prospective for clinical studies), and sample size (for clinical studies).

Bivariate comparisons for identified urology articles with lowest and highest number of citations were conducted. Continuous variables were compared using the student's *t* test for normally distributed variables, or the Wilcoxon rank-sum test for non-normally distributed variables. Categorical variables were compared using the chi-squared test or Fisher's exact test (SAS, version 9.4). The data were analyzed with a predetermined level of significance set to $P < .05$.

RESULTS

After the initial literature search, 15 articles from the 4 major international urology journals (JU, BJUI, Urology, and EU) were identified as having 0 citations accrued in the 10-year period following publication, while 35 articles were identified as having 1 citation. These were compared to the 50 articles from the same journals with the highest number of citations, which had a mean of 359.8 ± 158.2 citations since publication. There were many significant differences between the 2 cohorts of articles (Table 1). When compared to the cohort of articles with 0 or 1 citation, articles in the cohort of highly cited publications were significantly more likely to be a clinical study

(90% vs 74%, $P = .0373$), an international collaboration (32% vs 4%, $P = .0003$), and a multi-institutional effort (70% vs 40%, $P = .0026$). These articles often had a first author based in the United States (70% vs 32%, $P = .0001$). Highly cited articles were also more likely to be published in JU (64% vs 24%, $P = .0009$), have a focus in the field of urologic oncology (68% vs 34%, $P = .0022$) and report a statistically significant result in the article's abstract (62% vs 28%, $P = .0006$) and manuscript (86% vs 46%, $P < .0001$). These articles were more likely not to report conflicts of interest (88% vs 66%, $P = .0090$) and have a larger sample size (2611.47 vs 118.89, $P = .0465$).

Additionally, articles with the most citations had a significantly higher number of authors (7.26 vs 4.94, $P = .0009$) and words in the title (16.26 vs 13.68, $P = .0175$), abstract (287.34 vs 233.96, $P = .0002$), and manuscript (2693.76 vs 1978.16, $P < .0001$). These highly cited articles had more references (21.96 vs 16.68, $P = .0017$), tables (3.32 vs 1.90, $P = .0003$), and manuscript pages (5.90 vs 4.54, $P < .0001$) than articles in the same 4 journals with 0 or 1 citation in the 10 years following publication.

There was no significant difference ($P > .05$) in reported funding, presence of punctuation in the article title, presence of a nonurologist as an author, number of figures, or clinical study design (retrospective vs prospective).

DISCUSSION

Utilizing the combination of PubMed and iCite, we were able to identify and analyze primary research articles in the top 4 urology journals that were not cited or cited just 1 time in the 10 years following their publication and compare these articles to those in the same journals with the highest number of citations in the same period. Only 50 articles meeting the inclusion criteria were identified for the low citation cohort suggesting that the journals being studied have rigorous review processes to select impactful articles that will contribute and support future research endeavors in the field. This number is comparable to a study in the radiology literature where there were 47 uncited articles found in 3 journals over the same length of time and follow-up.¹ One of the underlying assumptions made regarding the citation count is that higher numbers of citations are equivocal with more substantial and significant impact. While the merit of this assumption has been called to question and other metrics have been developed to simultaneously gauge the quality and quantity of research, citation number still serves as a gross estimate of article impact.⁹ Newer metrics of impact, such as Altmetric, were discussed for potential inclusion in this study, however the time period of 1997-2007 predates many of the internet and social media aspects that the Altmetric ratings include hindering its utility in this particular study.

Despite the extensive peer-review process, some articles fail to attain impact in the literature measured by the number of citations. The number of citations garnered by a publication is 1 metric to denote the impact of a research article. Specifically, articles which are more frequently cited serve as a basis for discussion and a foundation for future research endeavors. More highly cited

Table 1. Comparison of articles with the lowest and highest citations

	Articles With the Lowest Number of Citations <i>n</i> = 50	Articles With the Highest Number of Citations <i>n</i> = 50	<i>P</i> Value
Journal			.0009
BJUI	8 (16.0)	3 (6.0)	
EU	11 (22.0)	5 (10.0)	
JU	12 (24.0)	32 (64.0)	
Urology	19 (38.0)	10 (20.0)	
Mean number of authors (SD)	4.94 (2.59)	7.26 (4.04)	.0009
Country			.0001
USA	16 (32.0)	35 (70.0)	
Non-USA	34 (68.0)	15 (30.0)	
Presence of urologists			1.0000
Urologist coauthor	47 (94.0)	48 (96.0)	
No urologist coauthor	3 (6.0)	2 (4.0)	
Presence of nonurologist			.1093
Urologists only	28 (56.0)	20 (40.0)	
Nonurologist present	22 (44.0)	30 (60.0)	
Mean number of other disciplines (SD)	0.74 (1.03)	1.10 (1.09)	.0927
Number of institutions			.0026
One institution	30 (60.0)	15 (30.0)	
Multi-institution	20 (40.0)	35 (70.0)	
Number of countries			.0003
One country	48 (96.0)	34 (68.0)	
Multinational	2 (4.0)	16 (32.0)	
Funding			.0913
Funding reported	37 (74.0)	29 (58.0)	
No funding reported	13 (26.0)	21 (42.0)	
Conflicts of interest			.0090
None declared	44 (88.0)	33 (66.0)	
Declared	6 (12.0)	17 (34.0)	
Number of words in title (SD)	13.68 (5.65)	16.26 (5.01)	.0175
Punctuation in title			.0718
No title punctuation	29 (58.0)	20 (40.0)	
Title punctuation	21 (42.0)	30 (60.0)	
Abstract word count (SD)	233.96 (71.75)	287.34 (66.28)	.0002
Manuscript word count (SD)	1978.16 (724.26)	2693.76 (718.35)	<.0001
Abstract results			.0006
No statistically significant result	36 (72.0)	19 (38.0)	
Statistically significant result	14 (28.0)	31 (62.0)	
Paper results			<.0001
No statistically significant result	27 (54.0)	7 (14.0)	
Statistically significant result	23 (46.0)	43 (86.0)	
Number of references (SD)	16.68 (6.81)	21.96 (9.37)	.0017
Number of tables (SD)	1.90 (1.61)	3.32 (2.14)	.0003
Number of figures (SD)	1.66 (1.56)	2.18 (1.89)	.1369
Number of manuscript pages (SD)	4.54 (1.36)	5.90 (1.87)	<.0001
Fellowship classification			.0022
Endourology	2 (4.0)	1 (2.0)	
Oncology	17 (34.0)	34 (68.0)	
Pediatric	5 (10.0)	0 (0.0)	
Men's health	8 (16.0)	7 (14.0)	
Female/urodynamics/reconstruction	14 (28.0)	8 (16.0)	
Other	4 (8.0)	0 (0.0)	
Clinical vs nonclinical			.0373
Clinical	37 (74.0)	45 (90.0)	
Nonclinical	13 (26.0)	5 (10.0)	
Study design (clinical)			.4791
Retrospective	8 (21.6)	12 (26.7)	
Prospective	29 (78.4)	31 (68.9)	
Both	0 (0.0)	2 (4.4)	
Mean sample size (SD) (clinical)	118.89 (291.45)	2611.47 (7485.66)	.0465

BJU, *British Journal of Urology International*; EU, *European Urology*; JU, *Journal of Urology*; . SD, standard deviation. Values are *n* (%) unless otherwise stated.

articles also gain more visibility, thus enabling opportunities for broader clinical and academic influence. While other fields have begun to examine the characteristics and factors affecting authorship and citation indices, there is a relative paucity of bibliometric studies focused on the urologic literature.^{1,10} As research continues to be an integral part of advancing urology as a discipline, examining the quality of the research that is published is important to maintain the integrity and development of the field.

Our results highlight article characteristics that may contribute to differences in citation numbers. However, many of these factors may be self-evident and align with the basic principles of investigational science and study design.¹ For example, studies with larger sample sizes and studies with statistically significant results were more highly cited by other studies. These findings were also identified in the radiology literature.¹ However, other significant differences identified were potentially not as instinctually obvious. Longer article titles, abstracts, and manuscripts were associated with more article citations. While the analysis of the radiological literature did not find that title length was associated with a particular cohort, it did report that longer abstracts and manuscripts were associated with more article citations.¹ While these findings might be confounded by being correlated with increased complexity of the studies, it also highlights that the way in which an article is linguistically presented may affect the article's impact to readers and likelihood of being cited in future publications.

Citation number as an index of research article quality and impact has been called to question and has led to the development of numerous other metrics.⁹ One study examining authorship and citation metrics suggested there may be implicit reader bias contributing to some articles being cited more often. In this study, researchers found that articles with an affiliation with a developing country were less likely to be cited, despite independent, blinded reviewers finding no difference in the quality of the research with articles published with an affiliation to developed countries.¹¹ Similar biases could be contributing to parts of the geographical affiliation differences seen in our study and other studies, as evidenced by articles with American first author affiliation having more citations as well as multi-institutional studies and international studies having significantly more citations.¹

Examination of the differences between the most highly cited and most infrequently cited articles in the same journals can be revealing to investigators as they move forward in designing and conducting research protocols and studies, particularly for individuals in academic medicine. Research activities are touted as an important part of academic promotion in urology as well as in other specialties.^{9,12,13} It is important to consider both the quality of research and the efficiency of the review process because of the substantial investment of time and resources that are involved in producing the literature. Understanding the characteristics that make articles more likely to be cited may influence study design, as researchers may choose to pursue investigative activities that have a higher likelihood of being subsequently cited in the literature.

This study has several notable limitations. First, this study was limited to 4 top-tier urology journals which cover the various subspecialties in the field. It is unclear if these results could be applied to other urology journals, or to other specialties. Methods used to analyze the cardiology literature captured a much broader scope of journals by examining articles published within a 10-year period across 222 cardiovascular journals and analyzing over 150,000 articles. Yet this approach limited the detail that they were able to explore in each article as their study focused primarily on citation number.⁵ Our study did have a small sample size of 50 articles in each cohort of articles analyzed, but this was chosen to highlight the differences between articles found at the extremes of citation count. A larger cohort of articles that includes studies with moderate numbers of citations could merit a future analysis to gain further insight into the characteristics of high impact research. The scientific rigor and quality of the studies was assessed with objective measures, such as sample size and study design. These metrics alone, however, may be inadequate in deciphering these endpoints which served as a limitation. Any mistakes in the categorization and cataloguing of research articles on PubMed or iCite could have additionally impacted our results. Among the various databases that collect citation information (Web of Science, Scopus, Google Scholar, and iCite), differences in citation counts are evident.¹⁴ We chose to use iCite because of investigator familiarity, ease of use, and widely available access for other users to allow for future validation studies. Additionally, both the iCite platform and Pubmed are services housed at the National Library of Medicine through the National Institute of Health, allowing for consistency of the data bridging the searches conducted through both these data systems. Finally, we did not take into consideration self-citations in this study, which could have skewed the number of citations that articles in the highly cited cohort accrued.

In conclusion, there are few articles in the top urology journals that have 0 to 1 citations in the subsequent 10 years following their publication. This suggests that the majority of articles chosen for publication contribute to further research. There were quantifiable differences between highly and infrequently cited articles demonstrating that certain characteristics are associated with higher citation number.

Acknowledgments. Research reported in this publication was supported by the National Center for Advancing Translational Sciences of the National Institutes of Health under award number UL1TR001417. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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