



# h-Index, Journal Citation Indicator, and Other Impact Factors in Neurosurgical Publications: Is There a Cost Factor That Determines the Quality?

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■ **OBJECTIVE:** There has been an increase in number of Neurosurgical publications, including open access (OA), in recent years. We aimed to compare journals' performance and the relationship to submission fees incurred in publication.

■ **METHODS:** We identified 53 journals issuing neurosurgery-related work. Quantitative analysis from various search engines involved obtaining h-index, Journal Citation Indicator (JCI), and other metrics such as Immediacy Index and 5-year impact factor utilising Journal Citation Reports. OA fees and individual subscription fees were collected. Correlations were produced using Spearman rho ( $\rho$ ) ( $P < 0.05$ ).

■ **RESULTS:** Median h-index for 53 journals was 54 (range: 0–292), with JCI median reported as 0.785 (range: 0–2.45). Median Immediacy Index was 0.797 (range: 0–4.076), and median for 5-year impact factor was 2.76 (range: 0–12.704). There was a very strong positive correlation between JCI and Immediacy Index, JCI and 5-year impact factor, and 5-year impact factor and Immediacy Index ( $\rho > 0.7$ ,  $P < 0.05$ ). It is unclear whether there was any correlation between the indices and the OA costs and subscription costs for personal usage ( $P > 0.05$ ).

■ **CONCLUSIONS:** Larger costs incurred for OA fees and subscription costs for personal use do not clearly reflect on the journals' performance, as quantified by using various indices. There appears to be a strong association with performance across the journals' metrics. It would be

beneficial to include learning about bibliometric indices' impact for research publications in medical education training to maximize the quality of the scientific work produced and increase the visibility of the information produced. The potential full movement to exclusively OA journals would create a significant barrier for junior researchers, small institutions, and full time-trainee physicians with limited funding available. This study suggests the need for a robust measurement of journals' output and the quality of the work produced.

## INTRODUCTION

A recent shift to open access (OA) publications, in this case neurosurgical publications, has resulted in a steady increase in publishing apart from traditional publishing.<sup>1</sup> The increasing number of publications in OA journals reflects costly expenditures for authors increase visibility of their research. The charge per article, the so-called article processing charge, is believed to provide financing to many OA journals in addition to funds from institutions or various associations.

There are some major advantages to publishing in an OA journal, such as increased ability to build a portfolio for researchers and track the findings in similar fields that avoids the need for database license purchase by local libraries. In addition, it is of great importance to recognize the transparency of the published work that would be widely available to the public, particularly researchers from lower-income countries or cross-disciplinary collaborations. However, the increased visibility of

### Key words

- Bibliometrics
- Cost
- Journal
- Neurosurgery
- Publication

### Abbreviations and Acronyms

**JCI:** Journal Citation Indicator

**JCR:** Journal Citation Reports

**OA:** Open access

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**Table 1.** Integrated Breakdown of 4 Bibliometrics, Open Access Costs and Yearly Subscription Fees for Personal Usage

Journal	Journal Type	Publisher	h-Index	JCI Average from 3 years 2017–2020	Immediacy Index	5-Year Impact Factor 2016–2020	OA Costs (USD)	Yearly Personal Subscription (USD)
<i>Neuro-Oncology</i>	Hybrid	Oxford University Press	105	2.49	4.171	12.997	4456	447
<i>Journal of Neurology, Neurosurgery and Psychiatry</i>	Hybrid	BMJ Publishing Group	—	—	—	—	2900	343.5
<i>Stroke</i>	Hybrid	AHA/ASA Journals	292	1.81	3.112	8.032	4145	284.5
<i>Fluids and Barriers of the CNS</i>	OA	BMC (Springer Nature)	0	1.28	1.229	6.127	2890	0
<i>Journal of Stroke</i>	OA	Korean Stroke Society	19	1.38	2.345	7.759	0	0
<i>Translational Stroke Research</i>	Hybrid	Springer	39	1.65	2.629	6.247	4480	93
<i>Journal of Neurointerventional Surgery</i>	Hybrid	BMJ Publishing Group	40	1.56	2.647	4.815	3000	251.5
<i>Journal of Neurotrauma</i>	Hybrid	Mary Ann Liebert, Inc	132	1.24	1.383	5.452	3200	1557.5
<i>International Journal of Stroke</i>	Hybrid	SAGE Journals	59	1.21	3.044	5.17	3000	182
<i>Journal of Neurosurgery</i>	Hybrid	Journal of Neurosurgery Publishing Group	189	1.77	3.637	5.152	3000	509.5
<i>Neuromodulation</i>	Hybrid	Elsevier	51	1.16	1.253	4.715	3500	205
<i>Neurosurgery</i>	Hybrid	Oxford University Press	183	1.64	3.772	5.558	4296	Unknown
<i>The Spine Journal</i>	Hybrid	Clarivate	—	—	—	—	3460	386
<i>Journal of Neuro-Oncology</i>	Hybrid	Springer	105	0.96	1.041	4.234	3860	147
<i>Pituitary</i>	Hybrid	Springer	57	0.77	0.962	4.167	3860	93
<i>Stroke and Vascular Neurology</i>	OA	BMJ Publishing Group	0	0.9	3.463	6.174	1500	0
<i>Neurosurgical Focus</i>	OA	Journal of Neurosurgery Publishing Group	81	1.21	0.857	4.67	Unknown	0
<i>Journal of Neurosurgical Anesthesiology</i>	Hybrid	Wolters Kluwer	57	1.04	2.156	2.991	3087.5	632.5
<i>Journal of Neurosurgery: Spine</i>	Hybrid	Journal of Neurosurgery Publishing Group	84	1.13	1.039	3.97	3000	376
<i>Neurospine</i> (first electronic JCR year 2020)	OA	Korean Spinal Neurosurgery Society	0	0.91	0.699	N/A	0	0
<i>Spine</i>	Hybrid	Wolters Kluwer	228	1.08	0.685	3.832	3895	1143.5
<i>European Spine Journal</i>	Hybrid	Springer	117	0.93	0.604	3.302	3860	147
<i>Neurosurgical Review</i>	Hybrid	Springer	52	0.92	1.043	3.136	3860	93
<i>Global Spine Journal</i> (first electronic JCR year 2019)	OA	SAGE Journals	0	0.8	0.427	3.356	1500	0
<i>Spinal Cord</i>	Hybrid	Springer	97	0.88	0.639	2.819	4480	181

<i>Operative Neurosurgery</i> (first electronic JCR year 2017)	Hybrid	Oxford Academic	16	0.81	1.609	2.621	3913.5	Unknown
<i>Neurosurgery Clinics of North America</i>	Hybrid	Elsevier	54	0.86	0.797	3.12	Unknown	438
<i>Journal of Neurosurgery: Pediatrics</i>	Hybrid	Journal of Neurosurgery Publishing Group	52	0.88	0.632	2.874	3000	515
<i>Brain Injury</i>	Hybrid	Taylor & Francis	92	0.72	0.509	2.692	3500	Unknown
<i>Journal of Neurosurgical Sciences</i>	Traditional	Edizioni Minerva Medica	33	0.44	0.855	2.059	Null	325
<i>Acta Neurochirurgica</i>	Hybrid	Springer	85	0.68	1.084	2.466	3860	147
<i>Journal of Stroke and Cerebrovascular Diseases</i>	Hybrid	Elsevier	—	0.48	0.638	2.185	3000	366
<i>Neurology India</i>	OA	Wolters Kluwer	43	0.37	0.492	2.433	Unknown	135
<i>Canadian Journal of Neurological Sciences</i>	Hybrid	Cambridge University Press	62	0.4	1.06	2.661	2152.5	60
<i>World Neurosurgery</i>	Hybrid	Elsevier	85	0.63	0.756	2.316	3120	909
<i>Journal of Spinal Cord Medicine</i>	Hybrid	Taylor & Francis	57	0.54	0.874	2.516	3300	343.5
<i>Journal of Clinical Neuroscience</i>	Hybrid	Elsevier	70	0.42	0.77	2.177	3320	918
<i>Clinical Neurology and Neurosurgery</i>	Hybrid	Elsevier	65	0.56	0.466	2.091	3310	252
<i>Clinical Spine Surgery</i>	Hybrid	Wolters Kluwer	12	0.58	0.593	2.139	3317.5	780.5
<i>Stereotactic and Functional Neurosurgery</i>	Hybrid	Karger	58	0.46	0.274	2.517	3530	1424
<i>Journal of Neurological Surgery Part B: Skull Base</i>	Hybrid	Thieme	36	0.44	0.225	2.057	2100	482
<i>Neurologia medico-chirurgica</i>	OA	Japan Neurosurgical Society	45	0.52	0.264	2.345	0 if within limit	0
<i>Journal of Korean Neurosurgical Society</i>	OA	Korean Neurosurgical Society	29	0.48	0.517	1.737	300	0
<i>Neurologia i Neurochirurgia Polska</i>	OA	Via Medica	22	0.36	0.881	1.386	350	0
<i>Interventional Neuroradiology</i>	Hybrid	SAGE Journals	30	0.44	0.349	1.599	3000	85
<i>British Journal of Neurosurgery</i>	Hybrid	Taylor & Francis	59	0.44	0.314	1.733	3300	Unknown
<i>Neurochirurgie</i>	Hybrid	Elsevier	27	0.4	0.286	1.595	3244	Unknown
<i>Child Nervous System</i>	Hybrid	Springer	—	—	—	—	3860	147

JCI, Journal Citation Indicator; OA, open access; USD, U.S. dollar; JCR, Journal Citation Reports; N/A, not applicable.

Continues

Table 1. Continued

Journal	Journal Type	Publisher	h-Index	JCI Average from 3 years 2017–2020	Immediacy Index	5-Year Impact Factor 2016–2020	OA Costs (USD)	Yearly Personal Subscription (USD)
<i>Journal of Neurological Surgery Part A: Central European Neurosurgery</i>	Hybrid	Thieme	28	0.38	0.237	1.257	2100	482
<i>Pediatric Neurosurgery</i>	Hybrid	Karger	68	0.37	0.095	1.327	3000	617
<i>Turkish Neurosurgery</i>	OA	Turkish Neurosurgical Society	22	0.35	0.209	1.107	0	0
<i>Neurocirurgia</i>	Hybrid	Elsevier	0	0.04	N/A	N/A	1650	239
<i>Cesta a Slovenska Neurologie a Neurochirurgie</i>	OA	Meditorial	12	0.1	0.182	0.293	0	0

JCI, Journal Citation Indicator; OA, open access; USD, U.S. dollar; JCR, Journal Citation Reports; N/A, not applicable.

given articles, in this case in neurosurgical journals, carries a considerable cost associated with the OA fee as well as subscriptions intended for personal usage in the case of hybrid OA inclusive journals. This is a pertinent topic for consideration to trainee physicians who are constrained by time in performing research and the onus of understanding the cost implications in getting their research work published. Trainee physicians need research publications to complete their training portfolio in the neurosurgical field, and it is our hope that a study such as this one would alleviate the time constraints associated with accessing the indices and costs database for full-time trainees.<sup>2</sup> There are 2 routes for publishing articles that we investigated in this study: via an exclusively OA route or via hybrid journals that allow publishing for an additional subscription fee.

We explored 4 journal bibliometrics, namely, the h-index, Journal Citation Indicator (JCI), Immediacy Index, and 5-year impact factor, to determine if the cost of publishing in an OA journal (based on the article processing charge) versus a hybrid journal (based on the subscription fee for personal usage) determines the quality of the neurosurgical journals considered. To date and to the best of our knowledge, this is the first comprehensive study in neurosurgery considering the impact of 4r bibliometric indices and their relationship to OA fees and subscription fees for personal usage.

The h-index (short for Hirsch index) is a bibliometric indicator that was introduced to demonstrate a journal's quality and performance. It reflects the vast majority of articles published in the journals rather than a fraction representation of highly cited articles. The h-index equivalent value is the number of articles (h) published in the journal that have been cited at least h times.<sup>3</sup> For instance, if we consider a journal that has published 100 articles cited a minimum of 100 times, the journal's h-index equals 100.<sup>4</sup> However, using the h-index is associated with some caveats; for instance, it does not distinguish between randomized controlled trials or peer-reviewed journals, which could attract the same citation value.<sup>3</sup>

The JCI is a journal-level metric representing journal citation impact across all disciplines. The JCI is field normalized, meaning the metric considers the subject field, year of publication, and document type to obtain the value for articles published in the most recent 3-year period. The field normalization feature offers an opportunity to compare articles against other similar articles. The first aspect that is considered to identify appropriate similar articles is the field/discipline feature. The idea is that the JCI would only compare articles against ones that are similar in terms of cited reference counts and reference ages as well as publication volume. The publication type focuses on comparing specific categories of publications, such as systematic reviews and meta-analyses. Lastly, the year of publication allows for comparison of articles with analogous recent articles leading to little bias when comparing the JCI value.<sup>5</sup>

The field normalization benefit provided by the JCI is a distinguishable factor from the Journal Impact Factor, which is another journal-level metric used in research. While the JCI considers the whole spectrum of journals thanks to the field normalization feature and provides a JCI value thereafter, the Journal Impact Factor does not consider all journals leading to a more robust journal-level metric demonstrated by the former. However, the

**Table 2.** Main Findings of Descriptive Statistics for 4 Bibliometrics, Open Access Costs and Yearly Subscription Fees for Personal Use

Value	h-Index	JCI	Immediacy Index	5-year Impact Factor	OA Costs	Subscription Personal Use Fees
Valid, number	49	50	49	48	39	35
Missing, number	4	3	4	5	14	18
Mean	64.27	0.84	1.18	3.5	\$2848.62	\$174.63
Median	54	0.785	0.797	2.76	\$3244.00	\$93.00
Range	0–292	0–2.45	0–4.08	0–12.70	\$0–\$4480	\$0–\$909
Minimum	0	0.04	0.1	0.29	\$0	\$0
Maximum	292	2.49	4.17	13.00	\$4480	\$909

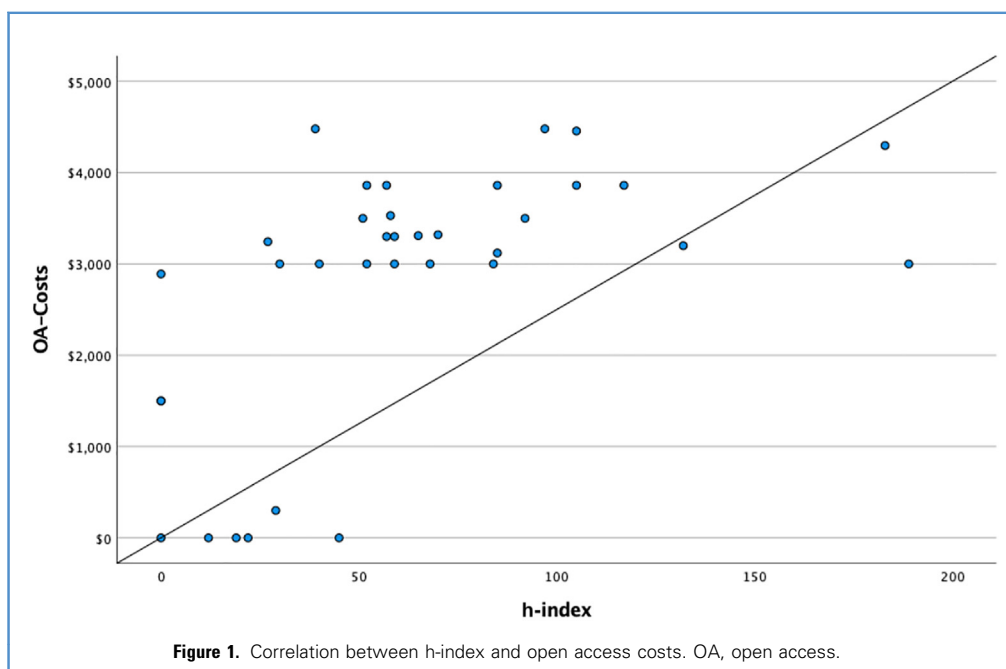
JCI, Journal Citation Indicator; OA, open access.

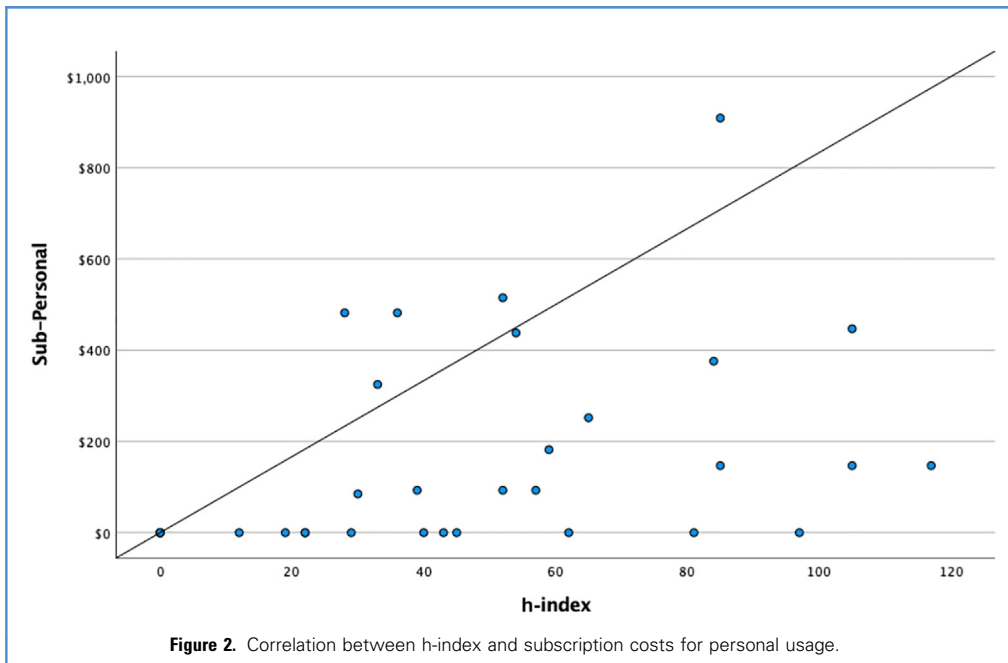
discussion regarding the Journal Impact Factor is outside the scope of this article.<sup>6,7</sup>

The journal Immediacy Index is calculated as the average number of times an article in a specific journal has been cited divided by the total number of articles published in a given year. This metric indicates how rapidly the articles are cited in the journal, and, most importantly, it accounts for the unequivocal advantage of large journals over smaller ones. As large journals tend to produce significantly more articles in a given year than smaller ones, the Immediacy Index discounts the inequality, solely taking into account per-article average. On the other hand, journals that yield a greater number of articles at the beginning of the year may have produced higher Immediacy Index values because there was a larger yearly opportunity for citations.<sup>8,9</sup>

The 5-year impact factor is defined as the average number of times the total amount of articles from the given journal published

in the last 5 years have been cited in the Journal Citation Reports (JCR) year. To obtain the 5-year impact factor value, the number of citations in the JCR year is divided by total number of articles that have been published over the past 5 years. When we consider the 5-year duration, we take into account 5 years before the current year. For instance, the 5-year impact factor for 2022 considers the following years: 2017, 2018, 2019, 2020, 2021. It is worth mentioning that the 5-year impact factor covers publications solely, and it does not correlate with institutions, individual articles, or authors. Interestingly, the 5-year impact factor was chosen over the standard 2-year impact factor because it could potentially reduce interdisciplinary differences between fields. Notably, the half-life of citations is believed to be shorter for disciplines such as medicine or specialties such as neurosurgery; hence, to decrease the discipline-specific bias, the 5-year impact factor was considered in lieu of the 2-year impact factor.<sup>10</sup>



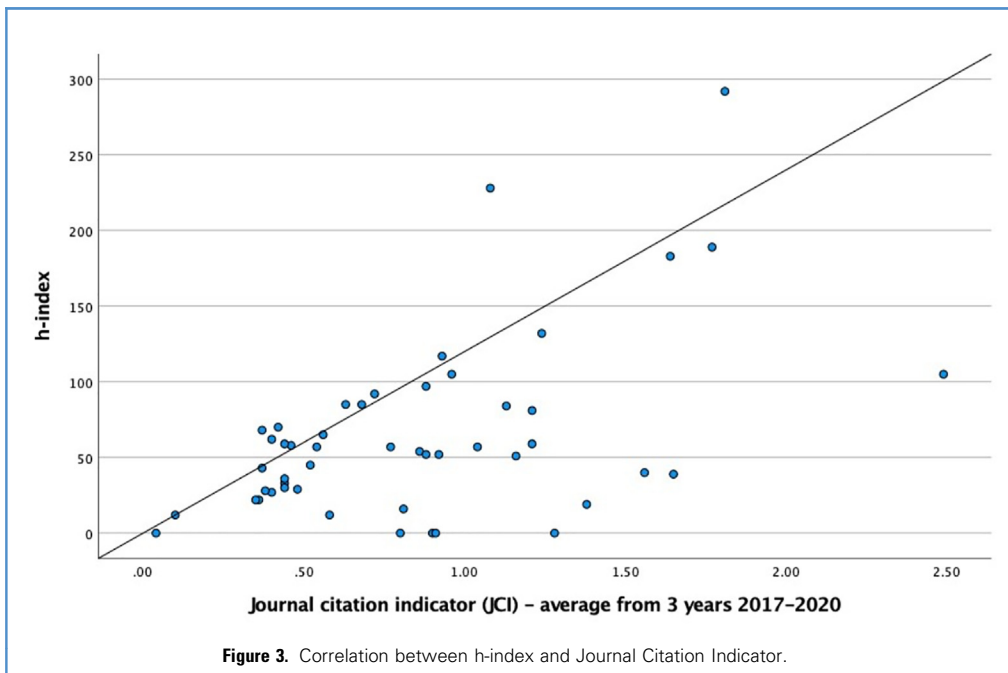


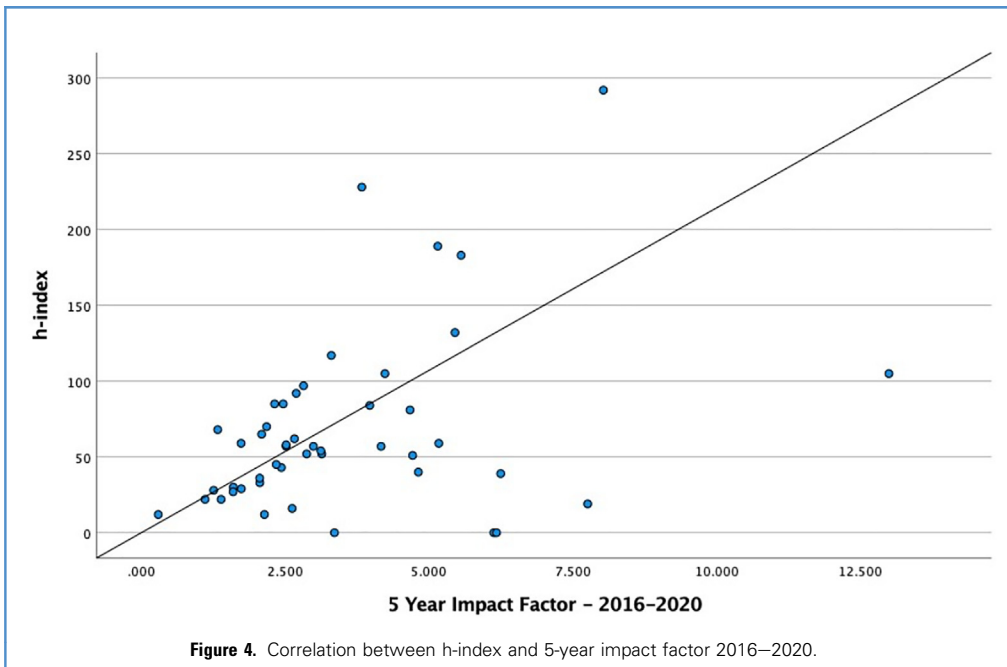
The objective of this study was to evaluate qualitative performance across 53 neurosurgical journals based on various journal metrics, including the h-index, JCI, 5-year impact factor, and immediacy index. Furthermore, the study explored the relationship between the qualitative journal’s performance based on data metrics and the costs associated with publications.

**MATERIALS AND METHODS**

**Data Collection**

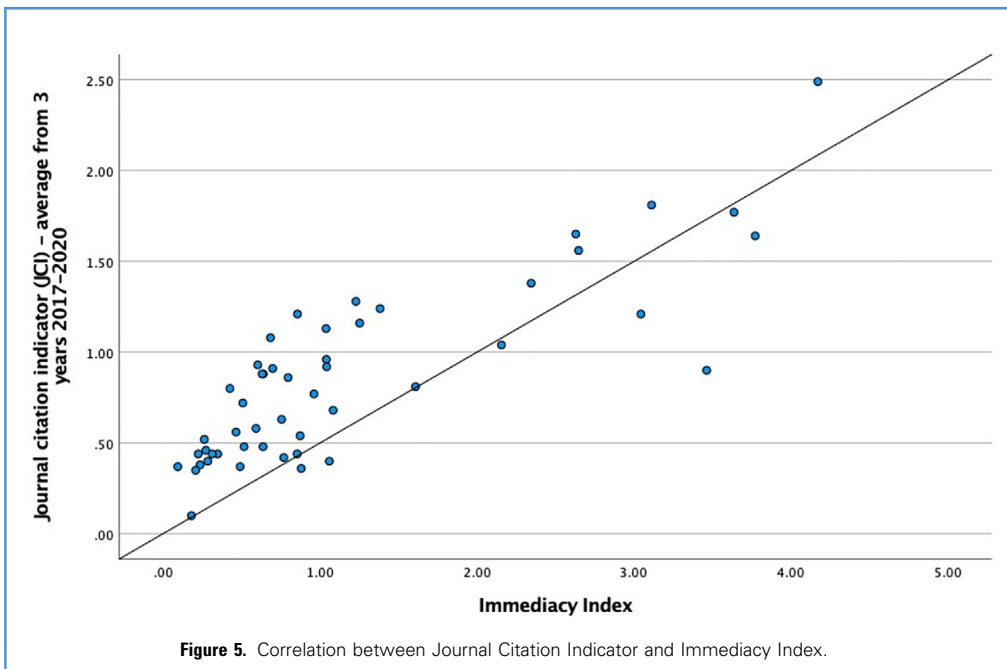
Using the Neurosurgery Journal Impact Factor 2021 obtained by neurosurgeons and researchers on social media as reported by Vacek and Kaliaperumal,<sup>11</sup> 53 journals publishing neurosurgical

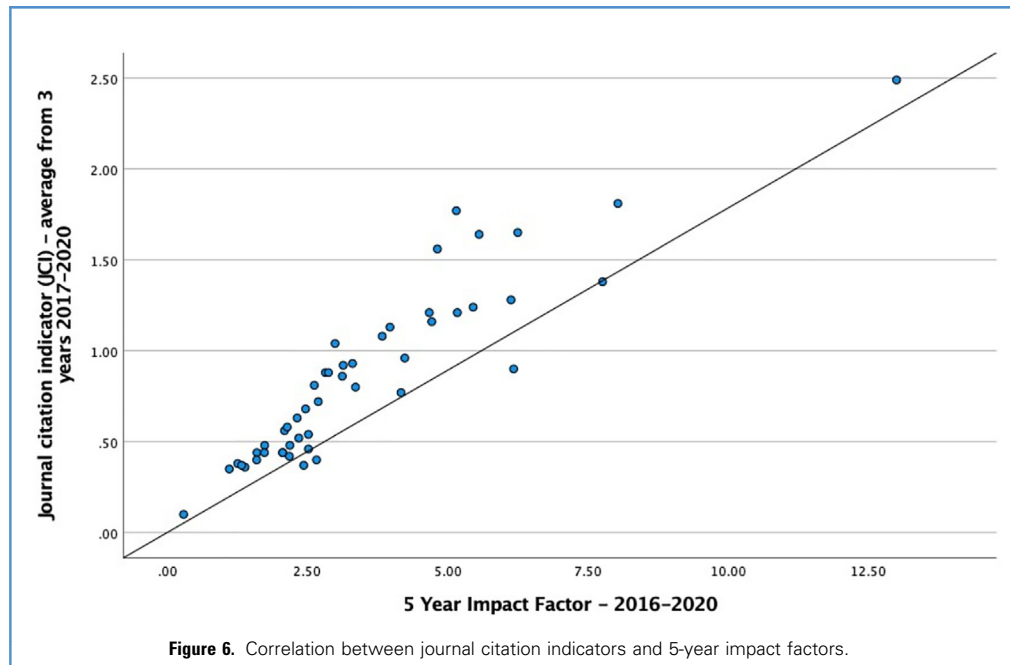




work were recognized. The h-index, JCI for the years 2017–2020, Immediacy Index, and 5-year impact factor for the years 2015–2020 were identified using the JCR software from Clarivate.<sup>12</sup> OA fees and costs associated with personal subscription were obtained from Vacek and Kaliaperumal.<sup>11</sup> The costs were

manually adjusted to U.S. dollars with current conversion rate at the time of publishing, rounded to 2 decimal places. An integrated breakdown of 4 bibliometric indices, OA costs, and yearly subscription fees for personal usage for 53 journals is presented in [Table 1](#).

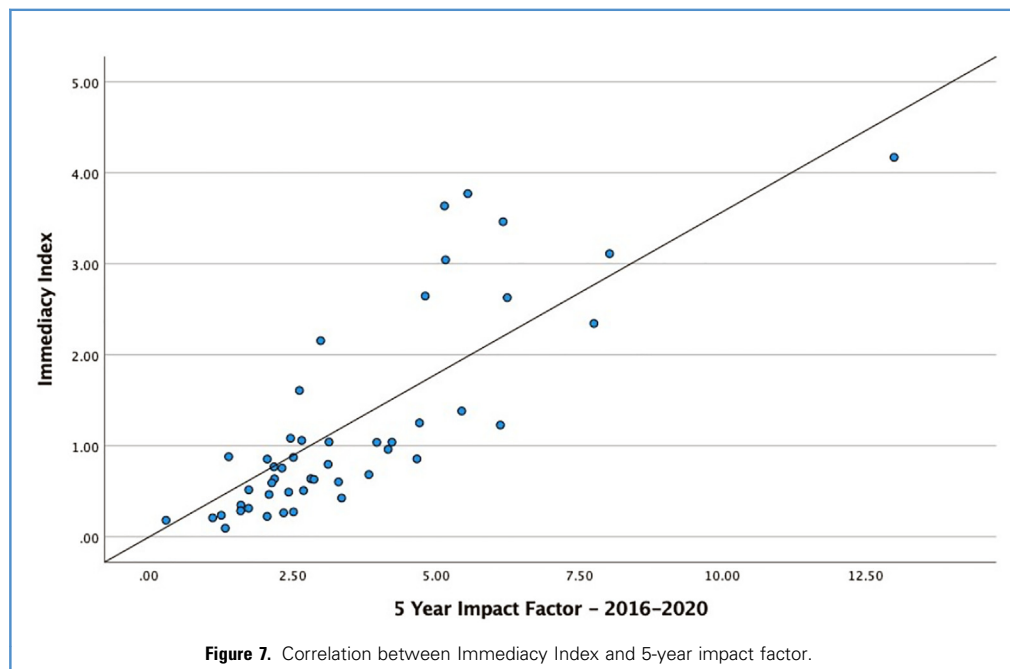




### Statistics

Data were collected and basic analysis involving extraction of mean, median, and range was calculated using IBM SPSS Statistics Version 27 software (IBM Corp., Armonk, New York, USA). The Spearman rho ( $\rho$ ) statistical correlations were

obtained using the aforementioned software as well, with the level of significance set for  $P < 0.01$ . The results of the Spearman ranking correlation between indices for neurosurgical journals and their respective correlations with the costs associated are shown in [Table 1](#).





**Table 3.** Bibliometric Indices, Open Access Costs, and Subscription for Personal Use Costs and Respective Correlations

Metric Factors/Costs	h-Index	JCI	Immediacy Index	5-year Impact Factor	OA Costs	Subscription for Personal Use Costs
h-index						
Correlation coefficient	1.000	0.399*	0.259	0.328*	0.637*	0.572*
P value (2-tailed)	< 0.001	0.004	0.075	0.024	< 0.001	0.001
Number	49	50	49	48	49	49
JCI						
Correlation coefficient	0.399*	1.000	0.781*	0.930*	0.259	0.033
P value (2-tailed)	0.004	< 0.001	< 0.001	< 0.001	0.127	0.854
Number	50	50	49	48	50	50
Immediacy index						
Correlation coefficient	0.259	0.781*	1.000	0.817	0.291	0.012
P value (2-tailed)	0.075	< 0.001	< 0.001	< 0.001	0.085	0.947
Number	49	49	—	49	49	49
5-year impact factor						
Correlation coefficient	0.328*	0.930	0.817	1.000	0.235	-0.056
P value(2-tailed)	0.024	< 0.001	< 0.001	< 0.001	0.175	0.761
Number	48	48	49	48	48	48
OA costs						
Correlation coefficient	0.637*	0.259	0.291	0.235	1.000	0.608*
P value (2-tailed)	< 0.001	0.127	0.085	0.175	< 0.001	0.001
Number	49	39	39	39	—	39
Subscription costs for personal use						
Correlation coefficient	0.572	0.033	0.012	-0.056	0.608*	1.000
P value (2-tailed)	0.001	0.854	0.947	0.761	0.001	< 0.001
Number	49	35	35	35	39	—
The 4 bibliographic indicators—h-index, JCI, Immediacy Index, and 5-year impact factor—used for this study are identified for the 53 journals cited. OA costs are reported in 39/53 journals, and subscription fees for personal usage are reported for 35/53 journals. JCI, Journal Citation Indicator; OA, open access. *Highlights correlations that are significant at the 0.05 level.						

## RESULTS

### General—Data Analysis

**h-Index.** Of 53 journals, 52 reported h-index on the JCR. An h-index >60, which is believed to be an exceptional metric for journal performance, was achieved in 18 of 52 journals.<sup>13</sup> A score >40, which is associated with outstanding performance, was reported for 13 journals, and a score >20, which is equivalent to good performance, was achieved by 9 journals.<sup>13</sup> An h-index <20 was reported for 5 journals.

**Journal Citation Indicator.** The JCI metric was reported for 50 of 53 journals. A JCI value >1 indicates that the journal has a better-than-expected citation performance in its respective category.<sup>14</sup> A JCI value <1 reveals that the journal has less than expected

citation performance in its respective category.<sup>14</sup> Of 50 journals, 15 had a JCI value >1, and 35 had a JCI value <1.

**Immediacy Index.** The Immediacy Index metric was reported for 49 of 53 journals. Immediacy Index values <1 were recorded for 30 journals. In 13 journals, Immediacy Index values between 1 and 3 were recorded. Finally, 6 journals obtained Immediacy Index values >3.

**5-Year Impact Factor.** The 5-year impact factor was reported for 48 of 53 journals. A 5-year impact factor >10 is considered an excellent score, which in our study was assigned to 1 journal.<sup>15,16</sup> Further, a score >3, which is believed to be a good outcome, was assigned to 20 journals.<sup>15,16</sup> Lastly, a score <3 was assigned to 27 journals, which is thought to represent a below-average score.<sup>15,16</sup>

**Table 4.** Ranking Order of 53 Journals Based on Open Access Costs and 5-Year Impact Factor

Journal	OA Costs (USD)	5 Year Impact Factor 2016–2020	Rank Number
<i>Neuro-Oncology</i>	4456	12.997	3
<i>Journal of Neurology, Neurosurgery and Psychiatry</i>	2900	N/A	35
<i>Stroke</i>	4145	8.032	5
<i>Fluids and Barriers of the CNS</i>	2890	6.127	36
<i>Journal of Stroke</i>	0	7.759	46
<i>Translational Stroke Research</i>	4480	6.247	1
<i>Journal of Neurointerventional Surgery</i>	3000	4.815	29
<i>Journal of Neurotrauma</i>	3200	5.452	24
<i>International Journal of Stroke</i>	3000	5.17	27
<i>Journal of Neurosurgery</i>	3000	5.152	28
<i>Neuromodulation</i>	3500	4.715	15
<i>Neurosurgery</i>	4296	5.558	4
<i>The Spine Journal</i>	3460	N/A	17
<i>Journal of Neuro-Oncology</i>	3860	4.234	8
<i>Pituitary</i>	3860	4.167	9
<i>Stroke and Vascular Neurology</i>	1500	6.174	41
<i>Neurosurgical Focus</i>	N/A	4.67	N/A
<i>Journal of Neurosurgical Anesthesiology</i>	3087.5	2.991	26
<i>Journal of Neurosurgery: Spine</i>	3000	3.97	30
<i>Neurospine</i> (first electronic JCR year 2020)	0	N/A	45
<i>Spine</i>	3895	3.832	7
<i>European Spine Journal</i>	3860	3.302	10
<i>Neurosurgical Review</i>	3860	3.136	11
<i>Global Spine Journal</i> (first electronic JCR year 2019)	1500	3.356	42
<i>Spinal Cord</i>	4480	2.819	2
<i>Operative Neurosurgery</i> (first electronic JCR year 2017)	3913.5	2.621	6
<i>Neurosurgery Clinics of North America</i>	N/A	3.12	N/A
<i>Journal of Neurosurgery: Pediatrics</i>	3000	2.874	31
<i>Brain Injury</i>	3500	2.692	16
<i>Journal of Neurosurgical Sciences</i>	Null	2.059	N/A
<i>Acta Neurochirurgica</i>	3860	2.466	12
<i>Journal of Stroke and Cerebrovascular Diseases</i>	3000	2.185	32
<i>Neurology India</i>	N/A	2.433	N/A
<i>Canadian Journal of Neurological Sciences</i>	2152.5	2.661	37
<i>World Neurosurgery</i>	3120	2.316	25
<i>Journal of Spinal Cord Medicine</i>	3300	2.516	21
<i>Journal of Clinical Neuroscience</i>	3320	2.177	18
<i>Clinical Neurology and Neurosurgery</i>	3310	2.091	20
<i>Clinical Spine Surgery</i>	3317.5	2.139	19
<i>Stereotactic and Functional Neurosurgery</i>	3530	2.517	14

Continues

Table 4. Continued

Journal	OA Costs (USD)	5 Year Impact Factor 2016–2020	Rank Number
<i>Journal of Neurological Surgery Part B: Skull Base</i>	2100	2.057	38
<i>Neurologia medico-chirurgica</i>	0 if within limit	2.345	N/A
<i>Journal of Korean Neurosurgical Society</i>	300	1.737	44
<i>Neurologia i Neurochirurgia Polska</i>	350	1.386	43
<i>Interventional Neuroradiology</i>	3000	1.599	33
<i>British Journal of Neurosurgery</i>	3300	1.733	22
<i>Neurochirurgie</i>	3244	1.595	23
<i>Child Nervous System</i>	3860	N/A	13
<i>Journal of Neurological Surgery Part A: Central European Neurosurgery</i>	2100	1.257	39
<i>Pediatric Neurosurgery</i>	3000	1.327	34
<i>Turkish Neurosurgery</i>	0	1.107	47
<i>Neurocirurgia</i>	1650	N/A	40
<i>Ceska a Slovenska Neurologie a Neurochirurgie</i>	0	0.293	48

The ranking number assigned is sorted in descending order based on the 2 criteria.  
OA, open access; USD, U.S. dollar; N/A, not applicable; JCR, Journal Citation Reports.

**OA Costs.** The fees associated with publishing in OA journals were reported in 39 of 53 journals.

**Subscription for Personal Use Fees.** Subscription for personal use fees were reported in 35 of 53 journals. Median personal subscription fee for 1 year was \$93 (mean: \$174.63; range: \$0–\$909).

**Table 2** presents the main findings of descriptive statistics for 4 bibliometrics, OA costs, and yearly subscription costs for personal use.

### Correlations

The statistical analysis yielded no significant correlations between the OA costs and the respective indices as well as the subscription for personal use costs and the respective indices ( $P > 0.05$ ), which have also been confirmed by Vacek and Kaliaperumal.<sup>11</sup> The correlation between the h-index and OA costs is shown in **Figure 1**, indicating that there is no significant correlation between h-index and associated OA costs.

No significant correlation was found between h-index and subscription for personal usage costs, which can be found in **Figure 2**. There was a moderate positive correlation between h-index and JCI ( $\rho = 0.399$ ,  $P = 0.004$ ), as can be seen in **Figure 3**, and h-index and 5-year impact factor ( $\rho = 0.328$ ,  $P = 0.024$ ), as shown in **Figure 4**. There was a very strong positive correlation between JCI and Immediacy Index ( $\rho = 0.781$ ,  $P < 0.001$ ), as demonstrated in **Figure 5**. Further, there was a very strong positive correlation between JCI and 5-year impact factor ( $\rho = 0.930$ ,  $P < 0.001$ ), as shown in **Figure 6**. Lastly, there was a very strong positive correlation between Immediacy Index and 5-year impact factor ( $\rho = 0.817$ ,  $P < 0.001$ ), as demonstrated in **Figure 7**. A summary of the 4 bibliographic indicators alongside the OA costs and subscription fees for personal usage and respective correlations is presented in **Table 3**.

### Which Journal Provides the Highest Impact Publication for the Value of OA Costs?

This article attempted to provide a ranking list for the best value journal based on the OA fee in comparison to the magnitude of reach that the journal offers based on the 5-year impact factor. **Table 4** demonstrates the integration of these 2 criteria and presents a ranking number for 48 journals in descending order. For instance, the journal's rank number 1 demonstrates the least favorable value for money outcome based on the OA costs and 5-year impact factor as shown in **Table 4**.

## DISCUSSION

### Correlation of Costs and Implications of the Study

There is an indication that larger costs for OA fees and subscription costs for personal use do not reflect on the journals' performance quantified using various bibliometric indices. This leads to a conclusion that the journal's impact based on the aforementioned metrics does not influence the cost of publishing in OA neurosurgical journals and the subscription costs intended for personal usage.<sup>17,18</sup> It is unclear whether mitigating the limitations of the study for future studies would result in different findings; however, at this time, we cannot successfully establish the magnitude of impact of bibliometric values and their relationship with the significant costs for OA fees and subscription costs for personal usage. Therefore, future researchers should use the data and conclusions included in this article before committing to low-magnitude journals despite greater OA costs and subscription costs. This point is of great importance in regard to low-income countries due to the fact that there is frequently limited research funding available compared with more-developed countries with widely available research funding, such as the United Kingdom.<sup>19,20</sup> Our findings strike a

balance for both low- and high-income countries, as the costs incurred do not reflect on the journal's performance and quality. The lack of transparency and visibility of predatory journals does not necessarily imply that greater fees are incurred in exchange for lower impact performance of journals based on our data; therefore, it is essential to validate index data included in our findings using different search engines. Providing these findings in conjunction with our findings would allow full-time trainees, physicians, and current medical students to be more mindful when publishing neurosurgical research.<sup>21</sup> It is essential to have this information on hand before devoting time to researching these valuable data. Further, one implication of this study is the necessity to obtain an h-index from different search engines to provide a more objective means to confirm our findings and fully appreciate the association with the rising costs of publications in the neurosurgical field. We have used 4 bibliometric measurements to estimate the impact of the neurosurgical journals that we believed were the most robust indices taken into account as shown by the correlations between the indices themselves; however, we appreciate that the study could have shown a more comprehensive perspective if more factors were considered.

### Correlation of Indices

There appears to be a strong association within performance across the journals' metrics, which could indicate a robust measurement of the journals' output and quality of the work produced. Our data provide confirmation that using these indices interchangeably provides a well-balanced perspective on the quality of a specific neurosurgical journal.<sup>22</sup> We argue that there is not a metric that is superior to another given the findings, and it is unique that despite different mathematical derivation, the bibliometric indices are strongly interlinked together.<sup>23</sup> We also suggest that use of the latter indices, namely, JCI, Immediacy Index, and 5-year impact factor, may provide a more complete picture of neurosurgical journals' impact. Ultimately, bibliometric measurements can recognize strengths and weaknesses of each neurosurgical journal and the potential for improvement in the future. The data and conclusions included in this study are of value in academic training and for future neurosurgeons where research writing process and further publications would be aided by the use of bibliometrics.<sup>17,24</sup>

### Limitations of the Study

The main limitation of this study is the single database used to explore 4 journal bibliometrics. We used the most robust Clarivate Analytics directory to assess the most current values of the aforementioned journals' metrics used. The Google Scholar database did not provide the complete metrics values for all 53

journals; hence it was difficult to draw any feasible conclusions, but this could be potential scope for improvement in the future.

We appreciate that the list of neurosurgical journals collated may not be a complete list inclusive of every journal; however, we ensured that the list is the most exhaustive data available up to date. The sample size of the neurosurgical and spinal-related journals is significantly smaller compared with journals from a similar subspecialization in surgery.

Notably, another limitation of the study was the inability to derive the costs of OA charges and personal subscription fees for all neurosurgical journals included. It would be vital to explore these costs further and increase the visibility before submission of articles for a particular journal.

Lastly, we recognize that we have limited our research of the journals' performance quality to 4 different indices; however, we aimed to use the most critically acclaimed and robust measurements that could shed the most well-rounded perspective on the journals' output. This may introduce bias as we cannot fully apprehend separate indices affecting each journal; however, we have attempted to equalize the distribution when considering what metrics to include.

### CONCLUSIONS

This is the first in-depth study to our knowledge exploring cost and its impact on the performance of neurosurgical journals. One of the highest fees for OA publication is currently \$4480 for one neurosurgical journal and with a \$1558 yearly subscription fee for personal usage in the hybrid journal; hence it is imperative to make this information widely available and more transparent to everyone. This study found no significant correlation between these costs and the journal's performance based on various indices. Therefore, researchers and institutions with smaller funding should consider these findings before sending manuscripts to OA or hybrid journals. Time is not a luxury in the scientific world, and we have attempted to make this knowledge more transparent through this study. It is our hope that this would ease the burden of accessing this difficult-to-attain information for academic and nonacademic researchers and benefit the neurosurgical scientific community.

### CRedit AUTHORSHIP CONTRIBUTION STATEMENT

**Katarzyna J. Minta:** Conceptualization, Methodology, Software, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Adam Vacek:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Chadrsekaran Kalia-perumal:** Conceptualization, Methodology, Writing – review & editing, Data curation.

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