The h-Index of Editorial Board Members Correlates Positively With the Impact Factor of Sports Medicine Journals

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Background: The h-index is a metric widely used to present both the productivity and impact of an author's previous publications.

Purpose: To evaluate and observe any correlations among the h-indices of 2015 editorial board members from 8 top sports medicine journals.

Study Design: Systematic review.

Methods: The sex, country of residence, degree, and faculty position of the editorial board members were identified using their respective scientific publication profiles. The h-index and other bibliometric indicators of these editorial board members were obtained using both the Web of Science (WoS) and Google Scholar (GS) databases. Nonparametric statistics were used to analyze differences in h-index values, and regression models were used to assess the ability of the editorial board member's h-index to predict their journal's impact factor (IF).

Results: A total of 422 editorial board members were evaluated. The median h-index of all editors was 20 (interquartile range [IQR], 19) using GS and 15 (IQR, 15) using WoS. GS h-index values were 1.19 times higher than WoS, with significant correlation between these values ($r^2 = 0.88$, $P = .0001$). Editorial board members with a PhD had significantly higher h-indices than those without (GS, $P = .0007$; WoS, $P = .0002$), and full professors had higher h-indices than associate and assistant professors (GS, $P = .0001$; WoS, $P = .0001$). Overall, there were significant differences in the distribution of the GS ($P < .0001$) and WoS ($P < .0001$) h-indices of the editorial board members by 2014 IF of the journals. Both the GS h-index (β coefficient, 0.01228; 95% CI, 0.01035-0.01423; $P < .0001$) as well as the WoS h-index (β coefficient, 0.01507; 95% CI, 0.01265-0.01749; $P < .0001$) of editorial board members were significant predictors of the 2014 IF of their journal.

Conclusion: The h-indices of editorial board members of top sports medicine journals are significant predictors of the IF of their respective journals.

Keywords: sports medicine; h-index; editorial board; impact factor

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The influence of evidence-based medicine (EBM) has been gaining momentum in recent years.[26] Sackett and colleagues first introduced the critical concepts of EBM, which focuses on understanding and improving the quality of research produced. EBM represents clinical practice that is being influenced by high-quality evidence, with the ultimate goal of providing the current best care to each individual patient.[27,28] With the high volume of research available, it is critical that clinical and surgical approaches are truly being selected based on the best available evidence. This is particularly important in surgical specialties such as orthopaedics, where the majority of evidence available is often of lower quality.[1] While most orthopaedic surgeons preferentially base decisions on high-quality, large clinical trials; unfortunately, the clinical decisions of some orthopaedic surgeons will also be influenced by extrinsic

factors such as perceived quality of the journal and investigator reputation.[9,12]

The subjective perception of the quality of journals and investigators by experts has been supplemented by citation metrics. Some of the methods to quantify and compare the contribution or impact of investigators and their research are their total number of publications, total number of citations, and number of citations per publication. While the total number of publications provides useful information on productivity, it is heavily influenced by the number of years an investigator has been producing research and does not describe the impact of their work to date.[14] Total and average number of citations does indicate the impact of papers produced but can be heavily influenced by a few papers with many citations and provide little information on productivity.[14] To combine these measures and summarize the importance and broad impact of an investigator's work, Hirsch proposed the use of an h-index in 2005.[14] An author is defined as having an index of "h" if the author has published "h" papers with at least "h" citations, where "h" is the maximal such number. While the h-index has been widely accepted, as it measures both the quantity and quality of research output and presents this information as a single number, there are several weaknesses of the h-index, resulting in numerous adjustments to the statistic. The h-index remains moderately dependent on the length of an investigator's career. Since the h-index can only increase, this metric may not be a reliable indicator of recent performance.[5] The h-index of an investigator has, however, been demonstrated to have a more accurate prediction of future productivity and impact than the number of papers, number of citations, or average number of citations.[15] These advantages, along with its widespread use and ease of calculation, has made the h-index a leading bibliometric variable.

The quality of a journal is often assumed to be assessable by its impact factor (IF), typically calculated from the Web of Science (WoS) database. The IF of a journal in a particular year is defined as the mean number of citations received in that year by all articles published in the journal in the previous 2 years. Journals with higher IFs have been shown to contain research with higher methodological quality.[23] Journals are only assigned an IF after a full 2 years of publication.

To ensure optimal decisions on journal content, there may be value in selecting editorial board members with higher impact publications in a relevant field of research. To date, it is unclear whether there is a correlation between the impact of orthopaedic and sports medicine journals and the productivity and impact of the research produced by the members of their editorial boards.

The purpose of this study was to determine the h-indices of the editorial board members for top sports medicine journals. Secondarily, we aimed to evaluate whether these h-index values were correlated with the IFs of these journals. It was hypothesized that journals with higher IFs would have editorial board members with higher h-indices, on average, than journals with lower IFs. The tertiary purpose of this study was to evaluate whether other factors such as sex, most advanced degree, and faculty position of the board member are related to their h-index.

METHODS

An Internet search identified the top 8 orthopaedic and sports medicine journals, ranked according to their 2014 WoS IF. The journals that were identified and chosen for this particular analysis were, listed according to descending impact factors, *The Journal of Bone & Joint Surgery* (*JBJS*), *Sports Medicine*, *British Journal of Sports Medicine* (*BJSM*), *The American Journal of Sports Medicine* (*AJSM*), *Arthroscopy: The Journal of Arthroscopic and Related Surgery*, *Medicine & Science in Sports & Exercise*, *Bone & Joint Journal*, and *Knee Surgery, Sports Traumatology, Arthroscopy* (*KSSTA*). The editorial board members of these journals were identified using the journals' respective websites. The total number of publications, total number of citations, and h-indices of each author were obtained using the WoS database, and these results were verified by searches in PubMed to ensure relative accuracy of the reported results. The Google Scholar (GS) database was also used to obtain an h-index value for each editorial board member. The GS database includes a more extensive set of citations from scientific journals, book chapters, as well as conference proceedings than the WoS database, which primarily includes citations from scientific journals alone.[8] The Scopus database was not used, as the publication information from before the year 1996 is limited. WoS was also used to obtain the IFs for each of the included journals.

The h-index of an author is calculated by organizing all papers published by that author in descending order based on the number of times each paper has been cited. The author has an h-index of "h" if "h" is a maximal number, such that at least "h" papers have been cited at least "h" times. The organization of papers and the h-index can be calculated by the GS and WoS databases based on the results of a query. The h-index of an author can be as low as zero and does not have an upper limit. Hirsch[14] identified the h-index of several of the most productive scientists in history and found h-index values for these authors as high as 191.

h-Index

Google Scholar. The advanced search function was used in GS. The author's full name was entered into the "with all of the words" search box, and the author's family name preceded by known initials and enclosed in quotes was entered in the "articles authored by" section. This search strategy was helpful in excluding most other authors with similar names. The results of the search were screened to ensure only the intended author was included. Any unintended results were further eliminated from the search using the "without the words" function. The h-index from the resulting search was recorded.

Web of Science. The author search function was used in WoS using the author's family name in addition to all known initials used in publications. The "exact matches only" function was selected to eliminate other authors with similar names. These results were refined by selecting the categories that most suited the research areas of the particular author, such as life science, biomedicine,

orthopaedics, and surgery. These refined searches were often necessary to exclude other authors with identical initials and family names. The h-index from this refined search was recorded in addition to the total number of publications and total number of citations.

Data Extraction

Relevant editor data were extracted from online university or clinic profiles, including their degree, country of residence, faculty position, and sex. A profile was identified for each editorial board member in this study, and thus, no attempts were made to contact the editorial board members for information directly. These data in addition to their total number of publications, total number of citations, and h-index were recorded in Microsoft Excel 2013 (Microsoft).

Statistical Analysis

Because both the GS and WoS h-index distributions in our data were not normally distributed according to the Ryan-Joiner normality test, nonparametric statistics were used for analysis. Medians and interquartile ranges (IQRs) were calculated for the bibliometric data. Overall, comparison of h-indices between editorial board members of different journals and positions was performed using Kruskal-Wallis 1-way analysis of variance. Editorial board members from multiple journals were included in calculations for each journal. Comparisons of the h-indices between any 2 groups of editorial board members were done using Mann-Whitney U tests. To compare independent datasets, the editorial board members of multiple journals were not included in these analyses. The Spearman rank correlation coefficient (ρ) was used to correlate the h-index with the other bibliometric values. A simple univariate regression analysis was used to correlate the h-index results from GS with the corresponding result obtained from WoS. Separate univariate regression analyses were used to correlate h-index values of editorial board members with the IF of their journal. Regression analyses were also used to assess trends in IF over time. A noncorrected P value of .05 or less was considered to be significant. However, this threshold was adjusted accordingly using the Bonferroni correction for multiple tests.[4] All statistics were calculated using Minitab statistical software (version 17; Minitab Inc).

RESULTS

General Bibliometric Results

The Internet search, conducted on August 18, 2015 and updated October 12, 2016, identified 28 editorial board members from *JBJS*, 26 from *Sports Medicine*, 60 from *BJSM*, 91 from *AJSM*, 63 from *Medicine & Science in Sports & Exercise*, 28 from the *Bone & Joint Journal*, 64 from *Arthroscopy*, and 90 from *KSSTA*. There were 16 editorial board members who served as editors for multiple journals, for a total of 422 unique editorial board members included in our analysis. The median GS h-index of all

included editorial board members was 20 (IQR, 19), while the median WoS h-index was 15 (IQR, 16). The editorial board members published a median of 55 (IQR, 93) papers, with their work being cited a median of 733 (IQR, 1714) times. The editorial board members were from a total of 38 different countries, with 41% of all members from the United States, 9% from Germany, 6% from Canada, and 5% from the United Kingdom. *AJSM* had the most geographically diverse representation of editorial board members (members from 25 countries), followed by *KSSTA* (members from 23 countries).

h-Index Correlations

There was a strong, significant correlation between the h-index and the total number of publications of the editorial board member ($\rho = 0.916$, $P < .0001$) and an even greater correlation between the h-index and total number of citations the editorial board member had amassed ($\rho = 0.973$, $P < .0001$). Analysis using linear regression demonstrated a significant correlation between the h-index values obtained from GS and the corresponding values obtained from WoS ($r^2 = 0.885$, $P = .0001$). The h-index from GS was, on average, 1.19 times greater than the h-index from WoS.

h-Index by Journal IF

Of the journals evaluated, *JBJS* had the highest 2014 IF (5.28) followed by *Sports Medicine* (5.038), *BJSM* (5.025), *AJSM* (4.362), *Medicine & Science in Sports & Exercise* (4.041), *Bone & Joint Journal* (3.309), *Arthroscopy* (3.206), and *KSSTA* (3.053). Overall, there were significant differences in the distribution of the GS ($P < .0001$) and WoS ($P < .0001$) h-indices of the editorial board members by 2014 IF. Both the GS h-index (β coefficient, 0.01228; 95% CI, 0.01035-0.01423; $P < .0001$) as well as the WoS h-index (β coefficient, 0.01507; 95% CI, 0.01265-0.01749; $P < .0001$) of the editorial board members were significant predictors of the 2014 IF of their journal (Figure 1). Of the journals evaluated, *JBJS* ($P = .02$), *Bone & Joint Journal* ($P = .05$), and *KSSTA* ($P = .003$) had a significant increase in IF from 2010 to 2014. There were no significant changes in IF from 2010 to 2014 for the journals *Sports Medicine* ($P = .80$), *BJSM* ($P = .09$), *AJSM* ($P = .11$), *Medicine & Science in Sports & Exercise* ($P = .80$), and *Arthroscopy* ($P = .90$). There were no significant differences in the median h-indices of editorial board members for journals with improving IFs (GS, 20; WoS, 16) compared with those of journals with IFs that did not change (GS, 20; WoS, 15) (GS, $P = .425$; WoS, $P = .15$).

h-Index by Degree, Faculty Position, and Sex

Overall, 11.2% of editorial board members in the 8 journals were female. The median total number of papers published by male editorial board members (48.3; IQR, 94.1) was not significantly greater ($P = .483$) than their female counterparts (44.5; IQR, 47). There were also no significant differences between the median GS or WoS h-indices of male and female editorial board members ($P = .8220$ and $P = .1890$,
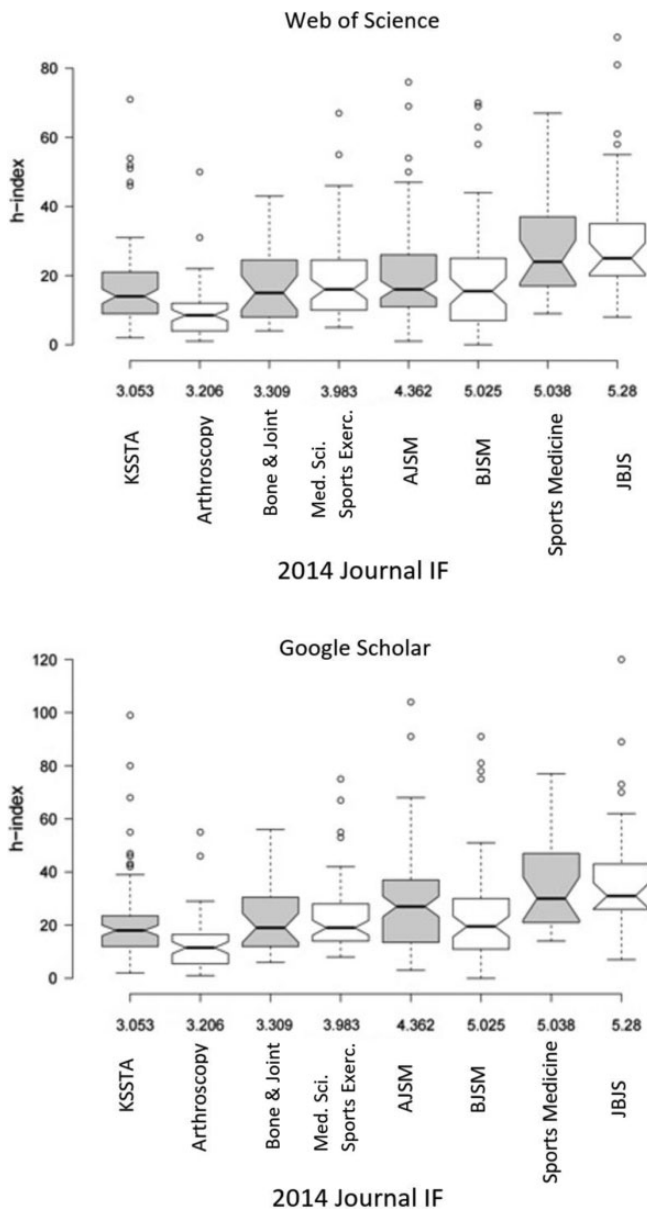
Figure 1. Boxplot depicting the h-index for each journal, arranged by 2014 Impact Factor (IF), using Google Scholar and Web of Science. The height of the boxplot represents the interquartile range (IQR). The dark line inside the box represents the median. The lower and upper whisker extend to the lowest and highest values within 1.5 IQR of the first and third quartile, respectively. The circles represent any outliers. The notches represent 95% CIs, calculated as ±1.58*IQR/sqrt(n), where n is the sample size of the particular variable.[7] AJSM, *American Journal of Sports Medicine;* BJSM, *British Journal of Sports Medicine;* JBJS, *Journal of Bone & Joint Surgery;* KSSTA, *Knee Surgery, Sports Traumatology, and Arthroscopy;* Med. Sci. Sports Exerc., *Medicine & Science in Sports & Exercise.*

respectively) (Figure 2). In total, 76.2% of all editorial board members had an MD designation, 26.9% received a PhD, 19.2% had both MD and PhD degrees, and 16.1% had

neither an MD nor a PhD designation. Using both GS and WoS, there were no significant differences between the median h-index of MD (GS, 17; WoS, 13) and non-MD editorial board members (GS, 17; WoS, 13) (GS, $P = .392$; WoS, $P = .439$) (Figure 3). Editorial board members with a PhD, however, had a significant higher median h-index (GS, 21; WoS, 17) than editorial board members without a PhD designation (GS, 17; WoS, 12) (GS, $P = .0003$; WoS, $P = .0012$) (Figure 4). There was a significant, nonrandom association between faculty position and median h-index of editorial board members, with professors having the highest median h-index (GS, 25.5; WoS, 21), followed by associate professors (GS, 17; WoS, 14.5) and assistant professors (GS, 13; WoS, 12) (GS, $P = .0001$; WoS, $P = .0001$) (Figure 5).

DISCUSSION

The key findings from this study include identifying a median h-index of 20 using GS and 15 using WoS for editorial board members of top sports medicine journals. The GS h-index as well as the WoS h-index for editorial board members are significant predictors of the current IF of their journal. There were no correlations, however, between the h-index of current editorial board members and the improvement in IF of their journal over the past 5 years. GS h-index values were an average of 1.19 times higher than WoS values for these editors of sport medicine journals. There was a strong correlation between the different h-index values, and thus, GS h-indices can be reasonably estimated by using a transformation function on WoS h-indices and vice versa. Faculty position was positively correlated with higher h-indices as full professors have significantly higher h-indices than associate and assistant professors. Similarly, editorial board members with a PhD had higher h-indices than those without a PhD.

In a relatively short period of time, the h-index has become one of the most commonly used bibliometric variables to measure an author's impact and success and has demonstrated predictive power for future performance.[2,15] While few studies in any discipline have evaluated the h-index of editorial board members, the values obtained in the present study were similar to the median h-index of 14, reported by Pagel and Hudetz,[25] based on 481 editorial board members of 10 prominent anesthesia journals, obtained using the Scopus database. Lee et al[18] reported mean h-indices of editorial board members from top neurosurgery, cardiology, oncology, and urology journals, ranging from 27.2 to 32.6, using the GS database. Using the Scopus database, Svider et al[29] identified the h-index of chairpersons from 20 random institutions and found general surgeons to have the highest mean h-index (27.8) followed by internal medicine (24.6), neurosurgery (20.3), otolaryngology (15.8), radiology (15.2), and anesthesia (12.3). However, Hirsch[14] himself identified potential issues that may arise when comparing the h-index of authors across different fields, where authors may have vastly different h-indices. For example, a mean h-index of 45 was identified using WoS for highly cited authors in the
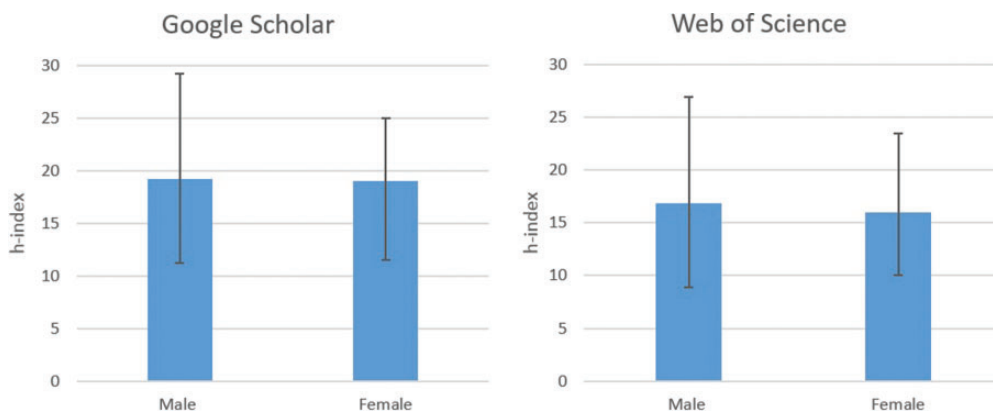
Figure 2. Median ± interquartile range h-index for male and female editorial board members using Google Scholar and Web of Science.
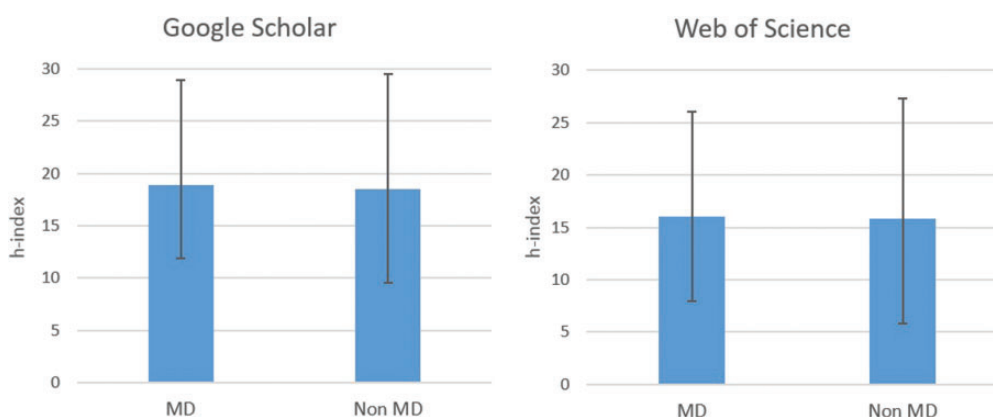

Figure 3. Median ± interquartile range h-index for those with an MD and those without an MD designation using Google Scholar and Web of Science.
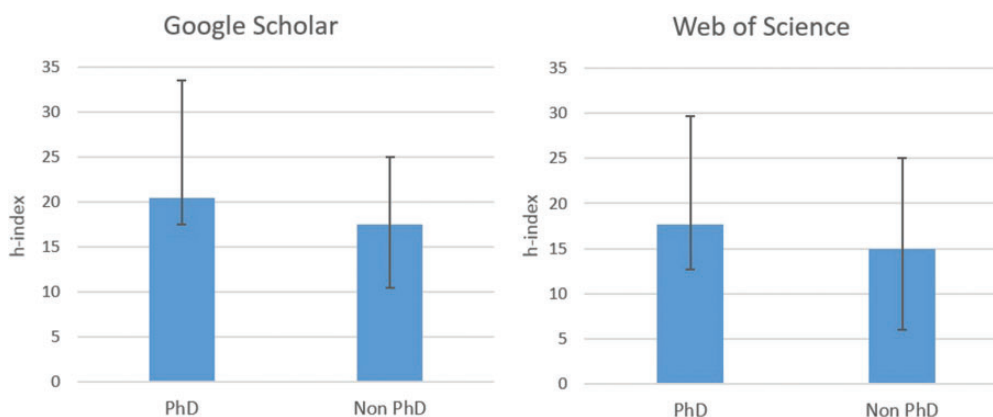

Figure 4. Median ± interquartile range h-index for those with a PhD and those without a PhD designation using Google Scholar and Web of Science.

disciplines of evolution and ecology.[16] The h-index of an author should ideally be compared only with other authors of the same discipline and specialty. The mean h-index of 10 editorial board members from top orthopaedic journals was calculated by Lee et al[18] as 15.8 using GS. Svider et al[29]

found that 20 orthopaedic surgery chairpersons had a mean h-index of 19.4 using the Scopus database. While no study has evaluated the average h-index of orthopaedic surgeons in general, the mean h-index of 366 surgeons who were full-time faculty members of hand fellowship programs in the
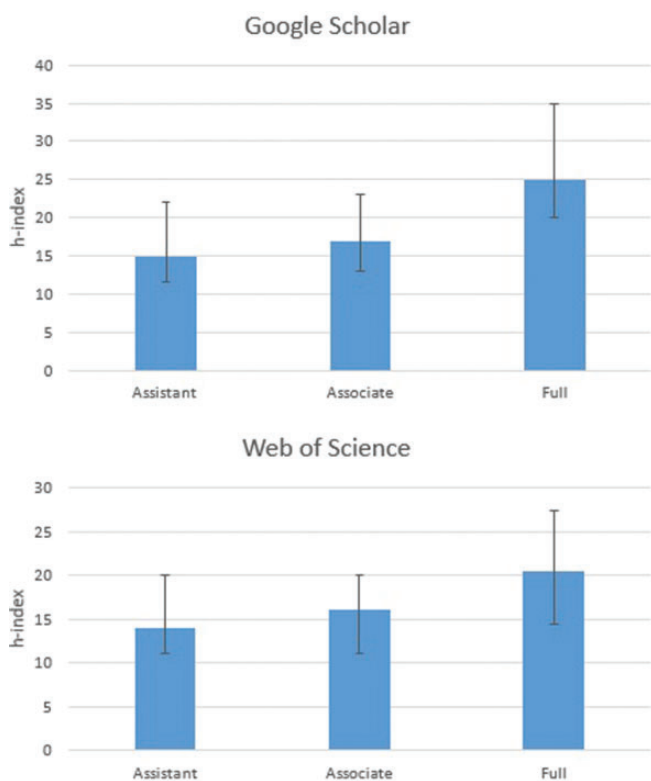
Figure 5. Median ± interquartile range h-index for each faculty position using Google Scholar and Web of Science.

United States (including 266 orthopaedic surgeons) was calculated as 10.2 using Scopus.[19]

The IF of a journal is the most widely used metric to compare the scientific usage of papers published in one journal compared with another. However, known limitations of the IF of a journal include cross-discipline discrepancy in citation rates; a short 2-year window that negatively discriminates clinical research in slowly evolving disciplines, including orthopaedics; and a lack of consideration into the nature of the citing journal.[13] Nevertheless, the IF of a journal is a fairly useful metric to compare journals within the same field and has been shown to predict the methodological quality of future publications.[13,23] Our study indicates that, in general, sports medicine journals with the highest IFs tend to have editorial board members with higher h-indices than journals with lower IFs. In fact, the h-index values of the editorial board members were significant predictors of their journal's IF. While such correlations do not allow for definitive causative inferences, these results may provide valuable information for journals during the editorial board member selection process.

In the present study, the editorial boards of the prominent sports medicine journals included members from 38 different countries, and 11.2% were female. The editorial board members of a journal are selected by the editor with input from other editorial board members and often are replaced after serving a term of 2 to 5 years. Because the decisions made by the editorial board members will ultimately dictate the research that will be included in the journal, it is important to ensure that these individuals have credentials that allow optimal publication decisions. Diversity among the members of the editorial board is essential to limit the bias of decisions and ensure inclusion of multiple perspectives. Meena and Chowdhury[21] found that 46 different countries were represented on the editorial boards of 18 top orthopaedic journals. However, lower income countries are poorly represented, as only 3 of these countries were classified as low- to middle-income economies.[21] While women represented only 5.4% of editorial board members of 5 top orthopaedic journals in 2007, their representation has increased consistently since 1970, when their representation was only 1.6%.[24] The proportion of female editorial board members identified in the present study is approximately double that reported in 2007, indicating that their representation is becoming more indicative of their fields of work. One criticism with the use of the h-index metric is its dependency on the number of publications of an author. Statistically, females publish fewer papers than males and could be at a disadvantage when being compared with their male counterparts using h-indices, despite other measures of productivity.[16] While differences in h-indices between the sexes have been reported by orthopaedic surgery subspecialty societies such as the Musculoskeletal Tumor Society (MSTS) in the past, the current study demonstrated no sex discrepancy in research impact in terms of the editorial board member's h-index.[20]

Several studies have identified a correlation between the h-index and the faculty position of the editorial board members in other disciplines such as neurosurgery and urology.[3,18] It should be noted that h-index and faculty position may both be moderately dependent on the length of the editorial board member's career, and thus, a relationship between these values might be expected.[5] However, because many of the decisions on academic promotion have predated the use of h-index as a marker of research success, it has been suggested that the h-index might act as a surrogate marker for criteria used by faculty promotion committees.[3] Our study has also demonstrated a strong correlation between the faculty position and h-index for editorial board members of top sports medicine journals.

Although there are substantial differences noted between the h-index values obtained from GS compared with the h-index from WoS, the significant correlation between these values demonstrates that this difference is predictable. The average difference of 1.19 between GS and WoS in the present study is similar to the corresponding values of 1.3 reported by De Groote and Raszewski[11] and 1.4 reported by Minasny et al.[22] This discrepancy may be due to the inclusion of non–peer-reviewed citations from Web sites in the GS algorithm.[17] Because of these differences, one must use caution when comparing h-indices and consider the databases being used to obtain the values. In the case that a comparison is made between 2 h-index values from GS and WoS, a transfer function should be used to more accurately relate these values.

Strengths and Limitations

Two databases were used to assess the h-index values in this study, thereby ensuring a greater coverage of peer-reviewed sports medicine literature. Some limitations of this study relate to known limitations involving the use of h-index values. Because the h-index depends on the number of citations, the factors that affect the citation rate of a paper could also affect an author's h-index. Some important factors that are positively correlated with the number of citations a study will receive include the following: the IF of the original publishing journal, the study methodology used, and the sample size.[6,30] The h-index also does not take into account whether a citation was a self-citation, which has been identified as a potential issue with this index.[10] Furthermore, the h-index remains moderately dependent on the length of an author's career and does not decrease, even for investigators who are inactive for a long period of time.[5] There is a time lag from the time of publication to the time a paper is indexed in databases such as WoS, GS, and PubMed, and some journals may not be indexed in these databases entirely, which are limits to consider when using these databases for bibliometric data. Furthermore, the findings of this study are limited to those from the analysis of 8 specific journals whose applicability may not extend to other journals that were not evaluated in the present study. Limitations with the search for the members of the editorial boards include the issue of name disambiguation (namely, authors using more than 1 variation of their names) and the issue of different authors having the same name. However, the comprehensive search strategy used for both databases was helpful in mitigating this issue. The Open Researcher and Contributor ID initiative assigns each author a unique alphanumeric code that can be used to identify the author's work throughout their career. Widespread use of such a system might aid in h-index calculations by mitigating the issue of author name ambiguity and additionally provide enhanced information for those examining the research impact of investigators such as promotion committees.

CONCLUSION

The h-index reported by the GS database tends to be higher than that from WoS in sports medicine, although one can be estimated from the other due to a very strong correlation between these values. Among editorial board members of the prominent sports medicine journals investigated in this study, full professors and those with a PhD demonstrated higher h-indices when compared with those with lower academic titles and those without a PhD, respectively. The h-index of editorial board members of top sports medicine journals are significant predictors of the IF of their journal.

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