The Scholarly Impact of Student Authorship in Ophthalmology

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Abstract

Purpose The H-index (H_i), an author-level metric of scholarly impact, is predictive of future scientific achievement. We sought to analyze the scholarly impact of student authorship on the H_i of corresponding authors (CAs) within a major academic journal in the specialty of ophthalmology.

Materials and Methods We compared the H_i of all unique CAs for manuscripts published in *Ophthalmology* (Journal of the American Academy of Ophthalmology) in 2008, 2012, and 2016. Data abstraction was completed twice: in October 2018 and March 2021. We further grouped published articles for CAs into those with student authors (StA) and those without (nStA). Primary analysis involved a linear regression analysis with change in H_i from October 2018 to March 2021 as the outcome variable, CA groups as the predictor variable, adjusting for the covariates of baseline H_i, the year when the CA published his or her article, number of research items published in October 2018, and the academic appointment of the CAs. Secondary analysis involved a linear regression analysis with change in H_i from October 2018 to March 2021 as the outcome variable, total number of student authors per CA as the predictor variable, adjusting for the covariates of baseline H_i, the year CA published his or her article, number of research items published in October 2018, and the academic appointment of the CAs.

Results The number of student authors increased from 168 in 2008 to 192 in 2016. Of the 902 articles, 316 articles were co-authored by one or more student authors. The average change in H_i of CAs publishing with student authors (StA, 11.0 ± 14.7) was significantly greater ($p < 0.0001$) than the change in H_i of CAs publishing without student authors (nStA, 6.2 ± 6.2). As the total number of student authors increased, the change in H_i of CAs increased linearly for all years combined (regression coefficient $= 1.70$, p-value < 0.0001).

Conclusion CAs publishing with students in the field of ophthalmology have a higher scholarly impact than those publishing without students. The development of programs to integrate students into ophthalmology research early on may encourage their pursuit of a career in ophthalmology, while advancing the careers of their mentors.

Keywords
- H-index
- student author
- mentor
- ophthalmology

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When students seek out opportunities for research with faculty members, they are often interested in learning about a specific field, gaining a potential mentor/advisor, and establishing a network that may help them in future endeavors, in addition to gaining experience and skills in scientific inquiry. As competition for residency positions continues to rise, scholarly work plays an even more integral role in the medical student's residency application. This is especially the case in competitive surgical specialties such as ophthalmology. Data from the San Francisco Match Program, the United States-based residency match program, shows that the number of applicants exceeded the number of available positions by 141 to 163% in any given match cycle from 2013 to 2022.[1] In the same time period, the average Step 1 score increased from 239 to 247, highlighting the increasing competition to successfully match into an advanced position.[1] With the United States Medical Licensing Examination Step 1 transition to pass/fail scoring in January 2022, program directors of various surgical subspecialties reported an increased importance of published research on residency applications.[2–5]

The H-index (H_i) is a cumulative measure of the scholarly impact and productivity of an author and was developed by physicist Jorge E. Hirsch in 2005.[6,7] The H_i is influenced by both quantity of publications and frequency of citations, and it is an author-level metric that has been validated as predictive of future scientific achievement.[7] Because H_i measures author productivity only, it is not influenced by journal impact factor.

In this study, we use H_i to evaluate the effect of student authorship on the scholarly impact of corresponding authors (CAs) in ophthalmology. We hypothesize that publishing with student authors (SAs) increases the scholarly impact of CAs, compared to publishing without SA.

Materials and Methods

We identified all authors from articles published in *Ophthalmology* during the years of 2008, 2012, and 2016. Articles from these three particular years were sampled because they are relatively recent to this present study, yet the time elapsed from the publication year is long enough for H_i to fluctuate. As the H_i is directly related to time since publication and depends on an author's citations in other works, a more recently publishing author will have a lower H index. Given this relationship, we withheld data collection after 2016 as CA's H-indices may not be well established for statistical analysis between our two groups. We chose *Ophthalmology* as our source to identify the pool of CAs due to the journal's high impact. Each author's degree was noted and ascribed in a database, with designations assigned as either CA, SA, or other author. SA was defined as an author with a nondoctoral, (e.g., nurse practitioner, registered nurse) degree; authors with bachelor's degrees, master's degrees, and PhD candidates were considered SAs.

Data abstraction was completed twice, in October 2018 and March 2021. For each of the sampled years, H_i values were identified for the CA at the time of publication of the article, as determined by Scopus.[8] For CAs who had publications in multiple years, the H_i was recorded once and the number of SAs was tabulated over time. There were no repeated observations per CA. SAs were divided into groups based upon whether they were first authors, second authors, or other authors. The CAs were designated as having student co-authors if at least one of their publications included a SA. The H_i for each CA was recorded in October 2018 and March 2021.

We compared CA groups, inclusion of SAs (StA) or no SAs (nStA) over time, based on the mean H_i of the CA using a linear regression analysis. We wanted to determine if the H_i of CAs who worked with SAs changed by a higher degree from 2018 to 2021 than those without SAs, so we set the change in H_i from October 2018 to March 2021 as the outcome variable, with the CA groups as the predictor variable, and adjusted for the covariates of baseline H_i, number of research items published in October 2018, the academic appointment of the CAs, and the year the CA published his or her article. A secondary linear regression analysis was completed with the total number of SAs per CA as the predictor variable and the change in Hi from October 2018 to March 2021 as the outcome variable, adjusted for the covariates of baseline Hi, number of research items published in October 2018, and the academic appointment of the CAs. The number of research items was determined from author profiles on ResearchGate, and includes published articles, chapters, conference papers, data, preprints, and full-texts. Statistical significance was determined by a p-value <0.05. Descriptive statistics were computed to describe the study cohort prior to excluding repeated CAs. Descriptive results were expressed as mean (standard deviation) and median for continuous measures, and counts with relevant percentages for categorical variables.

Results

When comparing the mean H_i from data recorded in October 2018 and March 2021, the H_i for each CA in both StA and nStA demonstrate a general increase over time (►**Table 1**). After excluding repeats, there were a total of 683 unique CAs, and 269 (39.4%) of these CAs published with SAs. This observation confirms the direct relationship between the time since publication and H_i. The number of SAs increased from 168 in 2008 to 192 in 2016, while the number of students as first or second authors increased from 41 in 2008 to 69 in 2016 (►**Table 1**). The number of publications including at least one SA also increased in this time, from 105 student-authored publications in 2008 to 119 student-authored publications in 2016 (►**Table 1**).

When data abstraction was completed in October 2018, the mean and median H_i were higher for CAs who published with students versus those who published without students for all years combined, as shown in ►**Table 2**. A similar trend was seen when data abstraction was again completed in March 2021, when the average change in H_i in the StA group was significantly higher than the average change in H_i in the nStA group. Analyses at both the October 2018 and March

Table 1 Descriptive analysis of articles from *Ophthalmology* 2008–2016

	2008	2012	2016	Total
Total number of articles	291	318	293	902
Number of student authors	168	150	192	510
Number of all authors	1,653	1,848	2,163	5,664
Number of students listed as first or second authors	41	42	69	152
Number of articles with student authors				
None	186	226	174	586
≥1 student author	105	92	119	316
1	66	59	72	197
2	25	20	32	77
3 or more	14	13	15	42
Number of authors per paper				
1–5 authors	151	110	102	363
6–10 authors	124	142	110	376
11–15 authors	13	18	40	71
16 or more	3	48	3	54

Table 2 Median H_i, mean H_i, SD, and change in H_i by corresponding author groups

Articles with student authors, median H_i/mean H_i (SD)			Articles without student authors, median H_i/mean H_i (SD)			
October 2018	March 2021	Change	October 2018	March 2021	Change	*p*-Value
28/32.6 (23.3)	40/43.6 (26.6)	7/11.0 (14.7)	22/25.0 (18.6)	27/31.3 (20.9)	4/6.2 (6.2)	<0.0001

Abbreviations: H_i, H-index; SD, standard deviation.

2021 timepoints were adjusted for the number of published research items, baseline H_i, the academic appointment of CAs, and the year the CA published his or her article. Furthermore, in the secondary analysis, it was found that as the number of SAs increased, the change in H_i increased linearly for all years combined (regression coefficient = 1.70, *p*-value <0.0001).

Discussion

Existing literature uses the H_i to analyze the effects of student authorship in other fields of medicine, namely radiation oncology, general surgery, and otolaryngology.[6,7,9–13] Our study aimed to analyze student contribution to research within the field of ophthalmology. We found that the scholarly impact, as measured by H_i, was higher for CAs who published with students compared to those who did not, achieving significance when combining data on CAs who published in 2008, 2012, and 2016. We also found that as the number of SAs increases, the change in H_i also increases linearly for all years combined. Our data indicate that the student–faculty partnership resulting in publications increases the H_i, and thus the scholarly impact, of CAs. Additionally, the impact of student authorship on the H_i of CAs may be stronger in ophthalmology compared to other fields of medicine previously studied.[9–12] In contrast to our findings, the change in mean H_i was not significantly different between nStA and StA in the fields of general surgery, radiation oncology, and internal medicine.[9–12] The difference in results may be due to differences in statistical analysis in our work compared to the studies in other fields, rather than intrinsic differences between medical fields. Unlike previously published works, our analysis was adjusted for potential confounders including the number of published research items, baseline H_i, the academic appointment of CAs, and the year the CA published their article.

Indicators for success in a surgical residency, such as teamwork, collaboration, effective communication, work ethic, and initiative, are promoted through research.[13–15] Importantly, research projects open opportunities for strong mentoring relationships, which play a major role in attracting students to surgical specialties.[15–17] In addition to these benefits, students have cited that their motivations to pursue research are in part influenced by the desire to build a stronger curriculum vitae to appear more competitive for residency applications.[18] While the motivation to pursue research projects may vary, authorship has historically been challenging to obtain for students.[19] Despite their interest, students often contend with barriers, such as lack of dedicated and funded time to pursue research projects and difficulty in finding mentors willing to guide students

through a project, and these barriers can stymie student productivity.[20–22]

Moreover, medical school curricula seldom emphasize ophthalmology topics or offer dedicated ophthalmology exposure through clerkships.[23–25] Given this, student participation in research can also serve as a means to gain exposure to the field, increase their visibility, and develop mentoring relationships early. All these factors will be helpful as students apply to residency programs, particularly as competition for residency positions rises.

Alternately, for faculty, as academic teaching institutions place significant emphasis on publications as a metric for faculty promotion and a barometer for national and international reputation,[26] these findings lend credence to the body of literature suggesting that the student–faculty partnership can be a synergistic and positive relationship for both.[27] In fact, surgical faculty in ophthalmology may have the most to gain in terms of research productivity by collaborating with SAs. It was shown that nonsurgical ophthalmology subspecialties, including uveitis, neuro-ophthalmology, and medical retina, have a higher H_i and number of published studies compared to surgical ophthalmology subspecialties such as cataract and refractive surgery.[28] Overall, CAs who collaborate with students are intrinsically motivated to mentor students and further contribute to the field. Given these motivations, they would be more likely to make choices, such as co-authoring with students, that increase their research productivity and H_i, compared to CAs who are less concerned with student mentorship.

There are some limitations to this study, some of which are inherent to the H_i calculation. The H_i is a composite value derived from all of a given author's publications in any journal, over time, and is not an individual calculation for each publication. Therefore, a "control group" of multiple H_i for the same author is not possible. However, comparing H_i of authors who did not work with students to H_i of authors who did work with students at the time of publication controls for time. Additionally, several factors may confound our reported number of SAs. Considering all nondoctorate authors as SAs may have overestimated the number of SAs. On the other hand, the time between research and publication may have led to graduate degrees for those who performed their research as students, which may have underestimated the number of StA. While most SAs were from the United States, other countries may have unique and variable barriers to publication for students, such as a high cost of publication or lack of funding, or students may be classified differently, impacting this variable in our analysis. Furthermore, it may be possible that students are seeking research mentors with higher H_i or ongoing research which may have overestimated H_i in the StA group; however, there is no literature to support this as a confounding variable and our analysis was adjusted for baseline H_i and academic appointment. Qualitative information to gauge students' choices in research mentors may provide greater insight into the possibility that students may seek out more prolific researchers and could augment the correlation between high H_i and student authorship. Furthermore, the data were collected from one journal in the field, which does not capture the full extent to which students participate in ophthalmology research. However, with a 5-year impact factor of 12.08, and a broad range of disciplines within ophthalmology represented, we felt *Ophthalmology* was an appropriate journal to evaluate student authorship in this surgical field.[29]

In summary, our study shows the number of SAs publishing in *Ophthalmology* is increasing while benefitting the scholarly advancement of CAs. We hope this study encourages students to involve themselves in research and encourages faculty to seek students for projects as a means to inspire, encourage, and maintain interest in ophthalmology while furthering their own careers and scientific discovery. Development of programs to improve faculty mentorship of student research as well as to better integrate students into ophthalmology research early in training may further encourage students' pursuit of a career in ophthalmology.

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Conflict of Interest
None declared.

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