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Scholarly impact of student authorship on surgical research

Munizay Paracha [a], Ariel E. Hirsch [b], Jennifer F. Tseng [a], David B. McAneny [a], Teviah E. Sachs [a, *]

[a] Boston University School of Medicine, Department of Surgery, USA
[b] Boston University School of Medicine, Department of Radiation Oncology, USA

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ABSTRACT

Background: Student authorship (SA) in research utilizes the H-index (H_i), to measure scholarly impact. We analyzed SA rates over time in the Journal of the American College of Surgeons (JACS).
Methods: We compared H_i of corresponding authors (CA) for articles over time (2006, 2008, 2010, 2012, 2014), comparing those with (SA) and without (nSA) student authors.
Results: SA doubled over time (70–146; $P = 0.02$) as did first or second SA rates (21–44; $P = 0.22$). Mean and Median CA H_i were similar independent of SA involvement. The change in H_i for CAs in 2006, 2008 and 2010 to current H_i (2016) was similar for SA and nSA groups (2006: 22.4 vs. 20.7; 2008: 20.2 vs. 20.6; 2010: 19.2 vs. 18.3; all $P > 0.05$).
Conclusions: The number of SA in JACS publications is increasing, without detriment to CA scholarly advancement. Involving students in surgical research should be encouraged.

Introduction

Surgical research, whether clinical, translational or basic science, serves as an opportunity for medical students interested in a surgical career to cultivate skills in scientific reasoning, practice evidence-based medicine, and establish contacts and connections in the field of surgery. With the increased competition for admission to surgical residency over the past several years, medical students interested in a surgical career are more focused on pursuit of research projects early on in their student years.

According to the National Residency Matching Program (NRMP), the average USMLE Step 1 score of students admitted to surgical residency in the United States was 235 in 2016, up from 222 in 2006.[1,2] Additionally, medical student participation in research is not only encouraged, but for some of the most competitive surgical residencies, it is often expected.[3,4,5] The average number of abstracts, presentations, and publications was 4.7 for applicants that matched into general surgery residency in 2016.[6]

Many of the same indicators of success in a surgical residency, such as collaborative skills, teamwork, and initiative, are the same as those that are promoted through participation in research.[7,8] Whether students' motivation be a genuine interest in the project, or – as often is the case – to enhance the curriculum vitae (CV) for application to residency, publishing as a student has historically been difficult to achieve.[2,9,10]

Literature on student authorship and mentorship in surgical research is limited. Most utilizes the H-index (H_i), a measure of the scholarly impact of a particular individual in a given year, in order to assess the effect of students on published research.[11,12] The H_i, developed by physicist Jorge E. Hirsch in 2005, has been used in literature to describe scholarly impact and as predictive power for future scientific achievement.[13,14] Svider et al. used the H-index to demonstrate a positive relationship between student authorship and scholarly impact, emphasizing the importance of mentorship as a key factor in successfully publishing research.[12] Still, the data on the impact of students on the field of surgical research is poorly understood. Even less well defined are the trends and long-term effects over time of student authorship on scholarly impact.

We sought to analyze student authorship rates over time in the Journal of the American College of Surgeons and examine the effects student authors have on the scholarly impact of corresponding authors (CA) in a major surgical journal over time utilizing the H-index.

* Corresponding author. Department of Surgical Oncology, 820 Harrison Ave, FGH Building, Suite 5007, Boston Medical Center, Boston, MA, 02118, USA.
E-mail address: teviah.sachs@bmc.org (T.E. Sachs).

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Methods

We identified all authors from articles published in the Journal of the American College of Surgeons (JACS) during the years of 2006, 2008, 2010, 2012 and 2014. Each author's degree was noted and ascribed in a database, with designations assigned as either corresponding author (CA), student author (SA) or other author. Student author was defined as an author with a non-doctoral, non-medical (ie: NP, RN) degree; authors with bachelor degrees, master degrees, and PhD candidates were considered student authors.

For each of the sampled years, H_i were identified for the CA at the time of publication of the article, as determined by Scopus[15] and Web of Science.[16] For CA who had publications in multiple years, all H_i were tabulated over time. CA were divided into groups for comparison based on whether or not SA were identified as co-authors of the publication. SA were also divided into groups based upon whether or not they were first authors, second authors, or other authors. CA with multiple publications within the same year were only counted once, and were designated as having student authors if at least one of their publications had an SA.

We compared CA groups over time based on the mean H_i of the CA, inclusion of SA or no student authors (nSA), using student's t-test with 95% confidence interval (CI) and significance was determined by p-value ≤ 0.05. The average difference in H_i of CA in 2006, 2008, and 2010 were determined by comparing CA past H_i from the year they published in JACS to their present H_i. The mean differences of past to present H_i between the SA and nSA groups were compared using a *t*-test and 95% CI ($p \leq 0.05$). Linear data trends were examined by assessing a goodness of fit model based on the means presented and reported as the value of R^2 (range 0–1).

Results

We identified a total of 1111 articles (2006: n = 213; 2008: n = 255; 2010: n = 201; 2012: n = 191; 2014: n = 251). The overall number of SA per publication year increased from 70 (6.3%) in 2006 to 146 (8.6%) in 2014 ($p = 0.02$) (Table 1), while the number of SA that were recorded as first or second author rose from 21 (1.9%) in 2006 to 44 (2.6%) in 2014, although this did not achieve significance ($p = 0.22$). The overall number of publications with at least one student author increased by 86%, from 52 in 2006 to 97 in 2014 ($R^2 = 0.82$) which was a significant increase over time (24.4% vs. 38.5%; $p < 0.01$) (Fig. 1). Mean and median H_i were similar for CA with and without SA involvement (Table 2). The change in the mean H_i for CA in earlier years (2006, 2008, 2010) as compared to their most recent H_i (2016) was also similar between CA groups with and without SA (Fig. 2). The majority of SA publications were categorized as clinical investigations (basic, translational, and clinical research).

When evaluating institutions, there were 760 unique institutions from 37 countries (Table 3). The mean H_i for CAs that published with more than 1 SA was not significantly different from that of CA who published with only 1 student, (20.1 vs. 20.3; $p = 0.9$). The majority of unique institutions from which SA published articles were in the US (70.5%), followed by Japan (7%) and Canada (4.1%). To compare, 45.7% of US institutions had at least one publication with a SA, while only 17.4% of international institutions did ($p < 0.01$) (Table 4). Within the US, institutions with the highest numbers of SA publications were concentrated in the South and Midwest.

Discussion

Scholarly productivity is a frequently used benchmark for faculty promotion in academic medical centers.[17] Additionally, promoting faculty with high scholarly impact, encourages opportunities for external funding to support and expand research projects without relying on internal resources.[18]

While faculty at academic medical institutions feel pressed to produce quality research for career advancement, students also feel pressure to participate in, present, and publish research in order to be competitive in the admission process for residency and doctoral programs. Students have reflected in surveys that their interest in participating in research was at least partially due to pressure to improve their credentials on their curriculum vitae.[10] This is even more prevalent among medical students interested in pursuing surgical careers.[19] Despite growing interest, students often must contend with barriers to participating in and publishing research, such as time constraints and finding willing mentors.[10,20,21,22]

Data on student authorship rates in surgery and its effect on

Table 1
Descriptive analysis of Corresponding Authors' (CA) publications in the *Journal of the American College of Surgeons* by year.

	All years		2006		2008		2010		2012		2014	
Total number of articles	1111		213		255		201		191		251	
Number of student authors	530		70		97		109		108		146	
Number of all authors	6850		1115		1523		1228		1288		1696	
% of student authors	7.7%		6.3%		6.4%		8.9%		8.4%		8.6%	
# of papers with student authors	n	%	n	%	n	%	n	%	n	%	n	%
No	755	68.0%	161	75.6%	191	74.9%	127	63.2%	122	63.9%	154	61.4%
Yes	356	32.0%	52	24.4%	64	25.1%	74	36.8%	69	36.1%	97	38.6%
1	*234*	*21.1%*	*38*	*17.8%*	*40*	*15.7%*	*48*	*23.9%*	*47*	*24.6%*	*61*	*24.3%*
2	*86*	*7.7%*	*11*	*5.2%*	*16*	*6.3%*	*19*	*9.5%*	*11*	*5.8%*	*29*	*11.6%*
3 or more	*36*	*3.2%*	*3*	*1.4%*	*8*	*3.1%*	*7*	*3.5%*	*11*	*5.8%*	*7*	*2.8%*
# of authors per paper	n	%	n	%	n	%	n	%	n	%	n	%
1 to 5	500	45.0%	126	59.2%	112	43.9%	95	47.3%	68	35.6%	99	39.4%
6 to 10	558	50.2%	80	37.6%	135	52.9%	100	49.8%	113	59.2%	130	51.8%
11 to 15	48	4.3%	6	2.8%	8	3.1%	6	3.0%	8	4.2%	20	8.0%
16 or more	5	0.5%	1	0.5%	0	0.0%	0	0.0%	2	1.0%	2	0.8%
Average H-index of CA	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
≤1 student author	20.3	13	31.5	18.2	29.5	17.5	27.4	16	27.3	14.8	20.3	13.9
>1 student author	20.8	15.6	35.5	14.4	28.1	15.7	26.5	15.2	23	16.5	22.7	16.2
P – value	0.87		0.46		0.82		0.45		0.16		0.88	

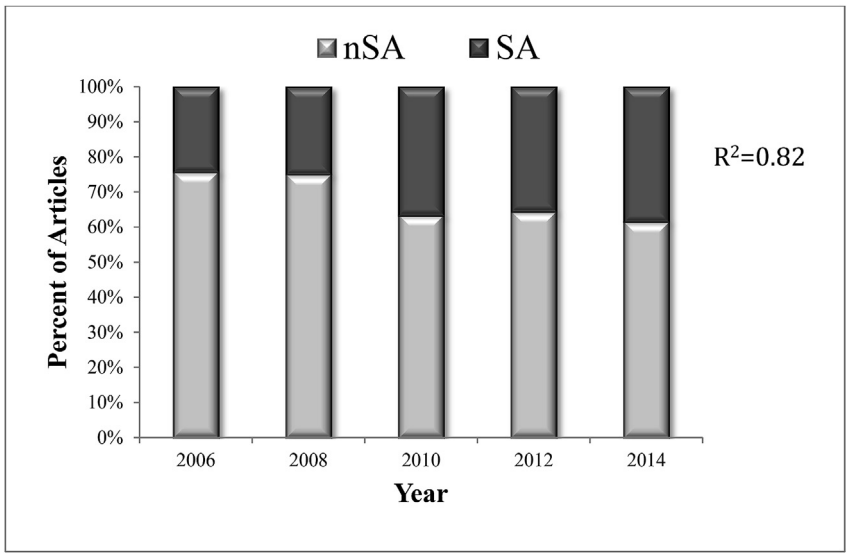

Fig. 1. Distribution of Articles with ≥1 Student Author (SA) compared to articles with no Student Authors (nSA) in the *Journal of the American College of Surgeons* 2006–2014.

Table 2
Mean H-index of Corresponding Authors' papers with (SA) or without (nSA) student authors over time in the *Journal of the American College of Surgeons*.

Year	No Student Authors				Student Authors				P
	n	Mean (SD)	Median	95% Confidence Interval	n	Mean (SD)	Median	95% Confidence Interval	
2006	161	30.1 (19.6)	26	33.1–27.1	52	32.6 (17.2)	32	37.2–27.9	0.42
2008	191	29.2 (19.6)	25	32.0–26.4	64	29.4 (15.7)	26.5	33.3–25.5	0.94
2010	127	27.0 (19.3)	24	30.3–23.6	74	27.4 (16.2)	27.5	31.1–23.7	0.86
2012	122	26.2 (20.7)	21	29.8–22.5	69	25.9 (15.2)	24	29.5–22.3	0.92
2014	154	22.2 (18.5)	17	25.1–19.3	97	20.5 (14.0)	18	23.2–17.7	0.42

SD: Standard Deviation

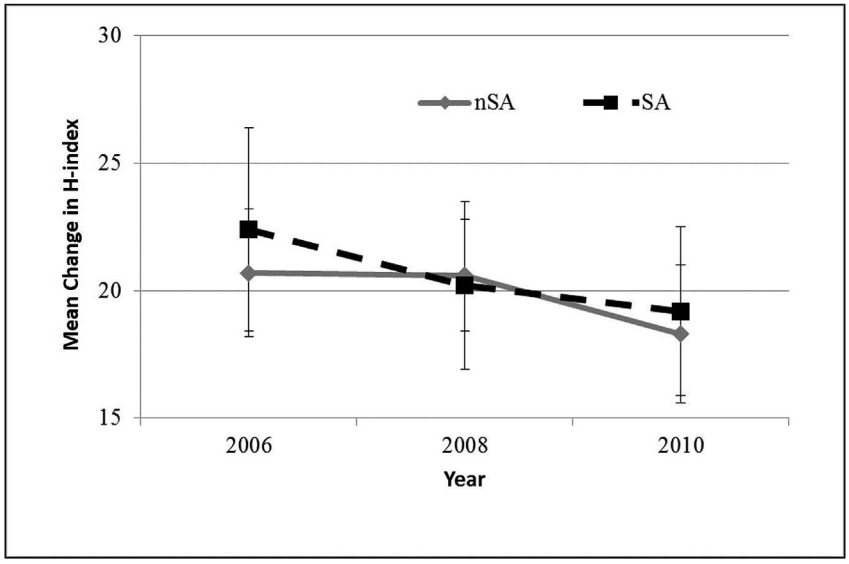

Fig. 2. Change in the mean H_i for Corresponding Authors (CA) in articles published in the *Journal of the American College of Surgeons* 2006–2010 compared to more recent H_i (2016) between CA groups with Student Authors (SA) and with no Student Authors (nSA).

scholarly impact over time remain limited. Our study focused on examining the change in student authorship rates since 2006, comparing H_i of CA of the nSA and SA groups, and determining if student authors affected the rate of growth of CA H_i.

Our analysis demonstrated an increase in student authorship in JACS from 2006 to 2014, with the overall number of student authors as first and second authors increasing by about 50%. These data reinforce the trend towards greater student participation in research, suggesting an increasing interest in surgery. Our study demonstrates no difference in the average H-indices of CA between

Table 3
Rates over time of all publications and those with student authorship by country, from the highest contributing countries to the *Journal of the American College of Surgeons*.

Authorship by Region/Country	Type of Author	All Years	Percent Student %	2006		2008		2010		2012		2014	
		n		n	%	n	%	n	%	n	%	n	%
Total	All	1111	32.0%	213	24.4%	255	25.1%	201	36.8%	191	36.1%	251	38.6%
	Student	356		52		64		74		69		97	
United States													
Northeast	All	253	17.4%	55	16.4%	59	11.9%	41	9.8%	44	25.0%	54	24.1%
	Student	*44*		*9*		*7*		*4*		*11*		*13*	
Midwest	All	226	41.6%	38	36.8%	44	40.9%	44	43.2%	43	27.9%	57	54.4%
	Student	*94*		*14*		*18*		*19*		*12*		*31*	
South	All	241	51.9%	37	45.9%	56	46.4%	48	60.4%	46	60.9%	54	46.3%
	Student	*125*		*17*		*26*		*29*		*28*		*25*	
West	All	153	33.3%	26	26.9%	35	17.1%	36	36.1%	26	19.2%	30	66.7%
	Student	*51*		*7*		*6*		*13*		*5*		*20*	
Canada	All	36	41.7%	7	14.3%	10	10.0%	8	62.5%	5	80.0%	6	66.7%
	Student	*15*		*1*		*1*		*5*		*4*		*4*	
Japan	All	57	8.8%	13	7.7%	10	20.0%	9	11.1%	4	0.0%	19	5.3%
	Student	*5*		*1*		*2*		*1*		*0*		*1*	
Australia	All	12	33.3%	3	33.3%	3	66.7%	3	33.3%	3	0.0%	0	N/A
	Student	*4*		*1*		*2*		*1*		*0*		*0*	

Table 4
Rates over time of all publications and those with student authorship by unique institution, from the highest contributing countries to the *Journal of the American College of Surgeons*.

Authorship by Unique Institution	Type of Author	All Years	Percent Student %	2006		2008		2010		2012		2014	
		n		n	%	n	%	n	%	n	%	n	%
Total	All	760	37.4%	159	32.7%	182	35.2%	138	37.7%	122	46.7%	159	37.1%
	Student	284		52		64		52		57		59	
United States	All	536	45.7%	106	44.3%	127	40.9%	100	45.0%	93	52.7%	110	47.3%
	Student	245		47		52		45		49		52	
International	All	224	17.4%	53	9.4%	55	21.8%	38	18.4%	29	27.6%	49	14.3%
	Student	39		5		12		7		8		7	
Japan	All	53	5.7%	15	6.7%	11	0.0%	9	11.1%	4	0.0%	14	7.1%
	Student	3		1		0		1		0		1	
Canada	All	31	45.2%	6	16.7%	9	44.4%	8	50.0%	3	66.7%	5	60.0%
	Student	14		1		4		4		2		3	
France	All	15	20.0%	3	0.0%	4	50.0%	3	33.3%	2	0.0%	3	0.0%
	Student	3		0		2		1		0		0	
United Kingdom	All	13	30.8%	0	N/A	5	20.0%	2	0.0%	4	75.0%	2	0.0%
	Student	4		0		1		0		3		0	
Australia	All	12	25.0%	3	33.3%	3	33.3%	3	33.3%	3	0.0%	0	N/A
	Student	3		1		1		1		0		0	

SA and nSA groups, which suggests no detriment to CA at the point of publication nor do they hinder CA long-term scholarly impact. We also found that the majority of SA were in US institutions, primarily in the South and Midwest regions, and that we could identify fewer SA from international institutions.

There are several limitations to this study additional to those inherent to the H_i. Several factors may confound the number of student authors. Considering all non-doctorate authors as student authors may have overestimated the number of student authors, while concurrently, the time interval between research and publication may have led to graduate degrees for those who performed their research as students, thereby underestimating the number of SA. Furthermore, other countries may have more barriers to publication for students, or may classify students differently, impacting this variable in our analysis. It is likely that in many cases, students seek out productive mentors when searching for research opportunities, which may augment the correlation between high H_i and student authorship. Additionally, more prolific researchers may be more amenable to working with students. Qualitative information to gauge students' choices in research mentors may provide greater insight into this topic. Given that this is a preliminary investigation, the data was collected from one journal, which does not capture the full extent to which students participate in surgical research. However, with a 5-year impact factor of 5.2, and a broad range of disciplines within general surgery represented, we felt JACS was an appropriate journal in which to evaluate student authorship in general surgery.[23]

Research is an indicator for success in residency.[24] Stain et al. concluded that among the most significant predictors for being ranked by highly competitive general surgery residency programs were Step 1 scores and publications.[25] Participating in research demonstrates interest in the field, the ability to collaborate, and work well in teams, leading to success in residency.[26] Mentors play a major role in attracting students to surgical careers.[27,28]

With a trend across medical schools in the United States towards decreasing time spent in surgical clerkships, participating in surgical research increases opportunities to engage with strong mentors and positive role models.[29,30,31] Surgical residency has one of the highest rates of attrition among residency programs in the United States.[32] Some reasons for this high attrition rate are poor mentorship in the clerkship and residency, and underdeveloped skills and interests. Early exposure to positive role models through research may inspire, encourage, and maintain interest in the field.

Given the benefits of participating in research, curriculum reform to incorporate protected research time may be useful to students and faculty. Incorporating protected research time into

medical school curriculums may serve to teach students specific research skills such as data analysis, results interpretation, and manuscript writing, ensuring high quality work. With a formal research curriculum, mentors may be able to provide greater guidance and supervision to students to maintain the caliber of the work. Current medical school research curricula that contain structured didactics and project requirements have shown potential benefit for motivating students to pursue careers in academic programs[33,34] Research experience is considered when evaluating applicants and promotes skills indicative of success in residency.

Conclusion

The number of student authors publishing in JACS is increasing, without evidence of a negative impact on the scholarly advancement of corresponding authors. Development of programs to improve faculty mentorship of student research, as well as to better integrate students into surgical research early on in training, may further encourage students' pursuit of a career in surgery.

Conflicts of interest

Munizay Paracha – none.
Ariel E. Hirsch – none.
Jennifer Tseng - none.
David McAneny – none.
Teviah Sachs - none.
No copyrighted information or patient photos were used in this study.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.amjsurg.2018.07.045.

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