

General

Does Research Training lead to Academic Success in Orthopedic Surgery? An Analysis of U.S Academic Orthopedic Surgeons

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BACKGROUND

Academic surgeons are invaluable for scientific advancement and training the next generation of orthopedic surgeons.

OBJECTIVE

This study aimed to describe a cohort of academic orthopedic surgeons currently in practice with common academic metrics.

METHODS

ACGME-accredited orthopedic surgery programs with a university affiliation were identified. The primary independent variable in this study was formal research training as defined by a research fellowship or attainment of a PhD. Outcomes included academic rank, h-index attained, number of publications, and funding by the National Institutes of Health (NIH).

RESULTS

1641 orthopedic surgeons were identified across 73 programs. 116 surgeons (7.07%) received formal academic research training. The academic training group and non-academic training group had a similar completion rate of clinical fellowship programs (93.97% vs 93.77%, $p=0.933$), attainment of other advanced degrees (10.34% vs 8.46%, $p=0.485$), and years since completion of training (17.49-years vs 16.28-years, $p=0.284$). Surgeons completing academic research training had a significantly higher h-index (18.46 vs 10.88, $p<0.001$), higher publication number (67.98 vs 37.80, $p<0.001$), and more likely to be NIH funded (16.38% vs 3.15%, $p<0.001$). Surgeons completing academic training were more likely to be associate professors (34.48% vs 25.77%), professors (25.00% vs 22.82%), and endowed professors (10.34% vs 2.43%) ($p<0.001$). On regression analysis, formalized research training was independently associated with h-index and NIH funding ($p<0.001$ for both).

CONCLUSION

Formalized research training, either as a research fellowship or PhD, is associated with an increased h-index and likelihood of NIH funding, although this association was not found for academic rank after adjusted regression analysis.

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INTRODUCTION

Academic surgeons are invaluable for both scientific advancement and training the next generation of orthopedic surgeons. However, only 14% of orthopedic surgeons choose an academic appointment after residency.¹ Incentivizing academic involvement among orthopedic physicians is important and involves many factors such as increasing autonomy, aligning job satisfaction, and leadership opportunities.² Prior research has suggested one predictive factor of academic appointment after residency is research involvement.³ Furthermore, the number of publications among students entering orthopedic surgery has dramatically increased in recent years, suggesting an increasing interest in academics among trainees.⁴ Recently there has been increasing interest in the relationship between structured research training pathways, such as MD-PhD or research fellowships, and appointment in an academic position after residency.⁵⁻⁷ However, little is known about the impact of training pathways on long term orthopedic academic appointment and research productivity. Quantifying the relationship between research training pathways and academic success may help inform both trainees interested in an academic career and administration in selection of new faculty appointment.

There are several methods commonly used to evaluate research productivity among academic physicians. One measure of research productivity is simply the total number of publications a physician has published over their career. However, this fails to account for the impact these papers may have in the research community. A commonly used measure is the “h-index” developed by Dr. Hirsch which evaluates a researchers impact based on number of publications in addition to number of citations and has been correlated with academic rank among orthopedic surgeons.⁸ Lastly, acquirement of funding from the National Institutes of Health (NIH) may be used as another metric evaluate a surgeon’s research productivity.

While completion of a research training pathway has been associated with measures of academic success among plastic surgeons, long term outcomes of orthopedic surgeons who completed a research training pathway remain understudied.⁶ This study aimed to describe a cohort of academic orthopedic surgeons currently in practice with common academic metrics. The primary outcome of interest was to elucidate the association between completion of a research training program and academic success defined by number of publications, h-index, academic appointment, and NIH funding.

METHOD

ETHICAL CONSIDERATIONS

This study is IRB exempt as it utilizes publicly available data.

STUDY DESIGN

This was a cross-sectional study of orthopedic surgeons in the United States. The FREIDA Database (freida.ama-assn.org/) was utilized to identify ACGME-accredited orthopedic surgery programs with a university affiliation, as of November 2021. A total of 103 programs were identified, a random generator was used to select 73 of the programs for further analysis.

Each residency program website was queried for the names of all faculty members within the department of orthopedic surgery. The following inclusion criteria was utilized to determine the faculty member’s eligibility for the study: (1) was appointed in a full-time academic faculty position in an orthopedic surgery department in an ACGME-accredited program, (2) had a complete faculty profile on a departmental website that included their academic rank and educational background, and (3) was actively practicing as an orthopedic surgeon. The data collection took place from November 2021-January 2022.

VARIABLES

The primary independent variable in this study was formal research training as defined by at least 1 year of basic science or clinical research training after receiving an MD, or attainment of a PhD, including whether awarded as a MD/PhD. Other variables considered included (1) years since graduation of residency program (2) completion of a clinical fellowship (3) completion of any other advanced degree.

Outcomes of interest included the academic rank of the surgeon within their department. This ranged from: Instructor, Assistant Professor, Associate Professor, Professor, and Endowed/Distinguished Professor. The h-index attained by each orthopedic surgeon and number of publications was also determined using the bibliometric database (SCOPUS, www.scopus.com/home.uri). Finally, whether the surgeon was funded by the National Institutes of Health (NIH) was recorded (reporter.nih.gov/search).

STATISTICAL ANALYSIS

Data was recorded in a Microsoft Excel spreadsheet then analyzed using SPSS (IBM SPSS Statistics, Version 28.0. Armonk, NY: IBM Corp). Descriptive statistics were computed to provide a sample overview. Independent t-test and chi-squared test of association was used to find associations between surgeons with and without formal academic training. Bivariate correlation statistics were computed to identify associations between the predictor variables and academic outcomes. Regression models were then used to predict h-index, NIH funding, and academic rank, controlling for confounding variables including research fellowship or PhD, other advanced degree, clinical fellowship, and years since completion of residency program. For all analyses, alpha value was set to 0.05 *a priori*.

RESULTS

DEMOGRAPHICS

In total, 1641 orthopedic surgeons were identified across 73 ACGME accredited programs. 116 surgeons (7.07%) received formal academic research training – either as a PhD or a research fellowship. 41 surgeons held a PhD, of which 19 (46.3%) were awarded as an MD/PhD.

The academic training group and non-academic training group had a similar completion rate of clinical fellowship programs (93.97% vs 93.77%, $p=0.933$), attainment of other advanced degrees (10.34% vs 8.46%, $p=0.485$), and years since completion of training (17.49-years vs 16.28-years, $p=0.284$). Surgeons completing academic research training had a significantly higher mean h-Index (18.46 vs 10.88, $p<0.001$), higher mean publication number (67.98 vs 37.80, $p<0.001$), and more likely to be NIH funded (16.38% vs 3.15%, $p<0.001$). Additionally, surgeons completing academic training were more likely to be associate professors (34.48% vs 25.77%), professors (25.00% vs 22.82%), and endowed professors (10.34% vs 2.43%) ($p<0.001$) ([Table 1](#)).

CORRELATION BETWEEN VARIABLES

Completion of a research fellowship or PhD was significantly correlated with h-Index ($r=0.17$, $p<0.001$), NIH funding ($r=0.17$, $p<0.001$), publication number ($r=0.13$, $p<0.001$), and academic rank ($r=0.15$, $p<0.001$).

Possession of another advanced degree was associated with h-Index ($r=0.08$, $p=0.002$), and publication number ($r=0.09$, $p<0.001$) but not NIH funding ($r=0.01$, $p=0.58$) or academic rank ($p=0.06$, $p=0.23$). There was no correlation between completion of a clinical fellowship and h-Index, NIH funding, publication number, and academic rank ($p>0.05$ for all) ([Table 2](#)).

REGRESSION ANALYSIS

Multiple linear regression to predict h-index as a function of academic variables was performed. Research fellowship or PhD was independently associated with h-index when adjusting for confounders (Beta coefficient = 0.07, $p<0.001$, [Table 3](#)). Other significant variables in the regression analysis included other advanced degree, academic rank, years since completion of residency, and NIH funding (all $p<0.001$).

Binomial logistic regression to predict NIH funding as a function of academic variables was performed. Research fellowship or PhD had 3.47 higher odds of receiving NIH funding, when adjusting for confounders ($p<0.001$, [Table 4](#)).

Finally, an ordinal logistic regression to predict academic rank as a function of academic variables was performed. Research fellowship or PhD was not independently associated with academic rank when adjusting for confounders (OR = 1.81, $p=0.42$). The statistically significant variables to predict academic rank included possession of a clinical fellowship (OR = 2.01, $p=0.01$), years since completion of residency (OR = 1.12, $p<0.001$), h-index (OR = 1.12, $p<0.001$), and NIH funding (OR = 2.21, $p=0.008$) ([Table 5](#)).

DISCUSSION

Contribution to research is a substantial component for the careers of many orthopedic surgeons. From residency applications to the end of fellowship training, research involvement is a continual part of the pathway. Increased research productivity during residency training has been associated with continued academic interests after residency completion.⁹ However, no prior studies have categorized the predictors for academic success among orthopedic surgeons, and the influence of formal research training.

The results of this study indicate that formal research training is predictive for future academic success, as defined by predicting h-index, and NIH funding. After controlling for confounding variables using regression analysis, formal research training had a statistically significant association for predicting h-index and NIH funding ($p<0.001$ for both), although this was not found for academic rank ($p=0.42$). One prior study found that the academic orthopedic centres with the highest productivity were Washington University, St. Louis, Hospital for Special Surgery, Mayo Clinic, University of Pennsylvania, and Thomas Jefferson University.¹⁰ Although this study utilized productivity metrics, including publication number, h-index, and NIH funding, it did not consider the role of formal academic training which may be a factor for academic surgeons pursuing these centres.

Our methodology was structured on a previous study by Lopez et al. which analysed academic success in plastic surgery.⁶ The authors also concluded that academic training is an independent predictor for NIH funding and h-Index, but not for academic rank. Promotion through the academic hierarchy is a complex process with many considerations including research, international reputation, and grant funding which may explain this finding.^{11–13} Lopez et al. conclude that their study provides support for enrolment of MD-PhD applicants and integration of research training within residency. Our study also supports this finding since 46.3% of all PhDs awarded within our sample were attained as an MD-PhD. Many MD-PhD candidates enroll in this program in order to work in both clinical practice and research which may enable them to be more successful in future academic endeavours as demonstrated by our study.¹⁴

A study conducted by Ence et al. assessed which factors are important for academic promotion among orthopedic surgeons.¹⁵ A higher h-index and longer career duration was independently associated with achieving a senior academic rank, but gender was not. Our study corroborates this finding since number of years post-residency and h-index were independently associated with academic rank on regression analysis. However, our study also found that completing a clinical fellowship and receiving NIH funding were also significantly associated. Additionally, our analysis focussed on the particular emphasis of the value of formal research training which has not been previously understood in the orthopedic field.

Academic success has also been evaluated in other specialties. Bobian et al. assessed if formal research training,

Table 1. Demographics table for total sample, including those with a research fellowship/PhD

	Total Number		Research Fellowship or PhD				
Variable			Yes		No		p-value
	n	% (or SD)	n	% (or SD)	n	(% or SD)	
Total	1641	100	116	7.07%	1525	92.93%	
Clinical Fellowship							
Yes	1539	93.78	109	93.97%	1430	93.77%	0.933
No	102	6.22	7	6.03%	95	6.23%	
Other Advanced Degree							
Yes	141	8.59%	12	10.34%	129	8.46%	0.485
No	1500	91.41%	104	89.66%	1396	91.54%	
Years since completion of training	16.36	11.68	17.49	10.38	16.28	11.77	0.284
Mean h-index	11.42	11.77	18.46	14.27	10.88	11.38	<0.001
Mean Publication Number	39.95	58.45	67.98	81.13	37.80	55.80	<0.001
NIH funding							
Yes	67	4.1	19	16.38%	48	3.15%	<0.001
No	1574	95.9	97	83.62%	1477	96.85%	
Academic Rank							
Instructor	16	0.98%	0	0.00%	16	1.05%	<0.001
Assistant Professor	766	46.68%	35	30.17%	731	47.93%	
Associate Professor	433	26.39%	40	34.48%	393	25.77%	
Professor	377	22.97%	29	25.00%	348	22.82%	
Endowed Professor	49	2.99%	12	10.34%	37	2.43%	

Table 2. Bivariate analysis to demonstrate correlation between variables.

	h-index		NIH funding		Publication Number		Academic rank	
	r	p-value	r	p-value	r	p-value	r	p-value
Research fellowship or PhD	0.17	<0.001	0.17	<0.001	0.13	<0.001	0.15	<0.001
Other advanced degree	0.08	0.002	0.01	0.58	0.09	<0.001	0.06	0.23
Clinical fellowship	0.01	0.78	0.01	0.67	0.01	0.72	0.08	0.052
Years since completing training	0.43	<0.001	0.15	<0.001	0.32	<0.001	0.65	<0.001
h-index	-	-	0.37	<0.001	0.90	<0.001	0.63	<0.001
NIH funding	0.37	<0.001	-	-	0.34	<0.001	0.33	<0.001
Number of publications	0.90	<0.001	0.34	<0.001	-	-	0.59	<0.001
Academic rank	0.63	<0.001	0.33	<0.001	0.59	<0.001	-	-

also defined by completion of research fellowship or PhD, was associated with higher academic achievement in the

field of ENT. Attainment of NIH funding was three times more likely for those with a research fellowship, and 8.6

Table 3. Multiple linear regression to predict h-index as a function of academic variables

	Beta Coefficient	p-value
Research Fellowship or PhD	0.07	<0.001
Other advanced degree	0.07	<0.001
Clinical Fellowship	0.04	0.02
Academic Rank	0.32	<0.001
Years since completion of residency program	0.10	<0.001
NIH funded	0.21	<0.001
R ²	0.442	

Table 4. Binomial logistic regression to predict NIH funding (yes/no) as a function of academic variables.

	OR	Lower CI	Upper CI	p-value
Research Fellowship or PhD	3.47	1.71	7.04	<0.001
Other advanced degree	0.85	0.33	2.21	0.738
Clinical Fellowship	1.23	0.33	4.63	0.756
Years since completion of residency program	0.98	0.95	1.02	0.329
h-index	1.08	1.04	1.13	<0.001
Publication Number	1.00	0.99	1.00	0.419
Academic Rank	-	-	-	<0.001

Table 5. Ordinal logistic regression to predict academic rank as a function of academic variables.

	OR	Lower CI	Upper CI	p-value
Research Fellowship or PhD	1.81	0.79	1.76	0.42
Other advanced degree	0.97	0.67	1.42	0.88
Clinical Fellowship	2.01	1.23	3.28	0.01
Years since completion of residency program	1.12	1.11	1.13	<0.001
h-index	1.12	1.09	1.14	<0.001
Publication Number	1.00	1.00	1.00	0.84
NIH funding	2.21	1.23	3.95	0.008

times more likely for with a PhD degree.¹⁶ Our study provides support to their analysis, as we also revealed the value of research training on academic productivity within orthopedic surgery.

Although this study is the largest known to analyse factors contributing to the academic success of orthopedic surgeons, it is not without limitations. Firstly, we did not analyse all faculty staff across every ACGME accredited program. However, by sampling 73 random institutes and capturing 1641 individual surgeons, our study was still well powered to find differences between the groups. Secondly, it is possible that additional confounding variables were not considered in the regression analysis due to limited information which is publicly available. However, our study utilizes a methodology applied to plastic surgery and ENT, and therefore believe the study still has value to the current literature base. Thirdly, our metrics for academic productivity

focused on NIH funding, h-index, and academic rank. Although these are important factors to consider, there are inherent limitations. For instance, the h-index is insensitive to papers with a high number of citations and low- and zero-cited papers are often ignored.¹⁷ Finally, research training was defined as research carried out after attainment of an MD, and therefore pre-residency research training was not included as part of the analysis.

CONCLUSION

With an increasing focus placed on the role of clinician-scientists and the development of academically productive orthopedic surgeons, this study has unveiled possible factors which can contribute to their success. Formalized research training, either as a research fellowship or PhD, is associated with an elevated h-index and likelihood of NIH fund-

ing, although this association was not found for academic rank after adjusting for confounding variables.

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AUTHOR CONTRIBUTIONS

Daniel Alsoof: Conceptualization, Formal analysis, Writing - Original Draft, Writing - Review & Editing

Mariah Balmaceno-Criss: Methodology, Writing - Review & Editing

Matthew Kovoov: Methodology, Writing - Review & Editing

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Eren Kuris: Conceptualization, Writing - Review & Editing, Supervision

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DISCLOSURES

DA, MBC, MK, JC, KJ, and CLM have nothing to disclose. EOK reports the following: consulting fees from Seaspine and Spineart. AHD reports the following disclosures: consulting fees from Stryker, Orthofix, Spineart, and EOS, research support from Southern Spine, and Fellowship support from Orthofix.

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