

## ORIGINAL RESEARCH

## PRACTICE MANAGEMENT

# On Track to Professorship? A Bibliometric Analysis of Early Scholarly Output

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## ABSTRACT

Academic productivity, demonstrated by a record of scholarly publication, is the main criterion for academic promotion. Nevertheless, there are no data on early-career productivity milestones to guide young faculty members aspiring to attain professor status.

We performed a bibliometric analysis to determine the number of scholarly papers published by current professors of orthopedic surgery within 5 years after their having acquired American Board of Orthopaedic Surgery certification (termed *early scholarly output*).

Median early scholarly output for all professors (N = 108) was 11 publications. We found medians of 5 first-author and 2 last-author publications, and 4 publications in *Clinical Orthopaedics and Related Research* or *Journal of Bone and Joint Surgery*. Median number of papers cited at least 50 times by year 5 was 2. The median number of total citations was 29.5, and median Hirsch index (*h*-index) was 3. Faculty who were *clinical* professors published fewer papers and acquired fewer citations than faculty who were promoted but did not have the *clinical* descriptor. Professors certified after 1995 were more productive than those certified before 1990.

This descriptive study provided benchmark data on early scholarly productivity of current professors of orthopedic surgery and demonstrated this benchmark has risen in more recent years.

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Professors of orthopedic surgery, by dint of their elevation to the highest academic rank, are men and women of achievement. Some of these surgeons have made their professional contribution primarily as clinicians; some have excelled as teachers. The common attribute of all medical school professors, though, is academic

productivity, manifest in the form of scholarly publications.

The question of how much scholarly productivity is enough is of practical concern to junior faculty members contemplating their own chances for being promoted to the rank of professor. Specifically, a junior faculty member may wonder if his or her current performance augurs well for promotion. For these young faculty members (and the mentors advising them), there are not much objective data to offer guidance.

Research within other surgical subspecialties has revealed that the Hirsch index (*h*-index) is correlated with promotion to full professorship status.<sup>1,2</sup> (An author earns an *h*-index of *h* if *h* of his or her papers has at least *h* citations.<sup>3</sup> For example, an author of 10 papers each cited once and an author of 1 paper cited 10 times both have an *h*-index of 1, whereas an author of 5 papers each cited 5 times has an *h*-index of 5, as does an author of 10 papers, 5 of which were cited 5 times or more, and 5 of which were cited 4 or fewer times.) To our knowledge, within orthopedic surgery there has been only 1 study of the relationship between early-career academic output and ultimate academic rank—a single-institution study of 130 residents showing that those pursuing academic careers published more articles during residency.<sup>4</sup>

To help address the relationship between early-career academic output and the attainment of professorship, we performed a bibliometric benchmarking analysis of current orthopedic surgery professors' productivity at a point likely before they were promoted to that rank. In measuring the early scholarly output of these now senior surgeons, we aim to give younger faculty members a basis of comparison for their own output and thus a sense of where they stand. Although a purely bibliometric analysis must be understood as a crude measure—one that fails to capture any of a professor's attributes in a domain other than scholarly output—it may nevertheless serve as a basis for meaningful advice.

Therefore, we performed a bibliometric analysis to determine the number of scholarly papers published by current professors of orthopedic surgery within 5 years after their having acquired American Board of Orthopaedic Surgery (ABOS) certification (termed *early scholarly output*). We tried to determine not only quantity (how many papers were published) but quality (how often papers were cited). Last, by comparing professors across periods, we tried to address the relevant question of whether professor-worthy early output is increasing over time.

## METHODS

A cohort of orthopedic surgery professors at nominally elite medical schools was constructed as follows. The *U.S. News & World Report* ranking list was consulted to identify the top 10 US medical schools, and in February 2014 the website of each school was accessed to identify the orthopedic surgery faculty. Names of orthopedic surgery professors were noted. The website for Duke University did not list academic ranks, so data for this school were obtained by personal communication. Whether a professor's title included the *clinical* descriptor was documented.

The ABOS website was then consulted to determine which of the faculty members were board-certified. Only certified faculty members were retained.

The Web of Science research platform (wokinfo.com) was used to identify each faculty member's early scholarly output in the field of orthopedics. After limiting the period under consideration to 5 years after the author was ABOS-certified, we performed an author search using all combinations of first and middle initials. Results were then refined by category *orthopedics* and document type *article*. To reinforce the search specificity, we manually reviewed the generated bibliography and retained only correctly identified papers.

A Web of Science citation report was then generated for the author. All bibliometric data were recorded. The quantity of early output was logged as number of papers in 1 of 3 bins: first author, last author, and middle author (any author except first or last). Quality was approximated by total number of times the author was cited across total output. In addition, number of publications in *Clinical Orthopaedics and Related Research (CORR)* and *Journal of Bone and Joint Surgery (JBJS)* was recorded.

To further make an inference about the importance of papers published in this early career window, we calculated an *h*-index for this “5 years post ABOS certification” bibliography. As noted, an author earns an *h*-index of *h* if *h* of his or her papers has at least *h* citations.

The faculty member was assessed for publication of any “blockbuster” research, defined as a paper that had been cited at least 50 times between publication date and present day.

Last, to assess trends, we compared our output metrics for nonclinical professors ABOS-certified before 1990 versus after 1995. Significance was set at  $P < .006$  using a conservative Bonferroni correction. Scatter plots were generated for total publications, citations, and *h*-index versus time since ABOS certification. Stata Statistical Software Release 11 (StataCorp) was used to analyze the data.

## RESULTS

Of the 108 professors identified, 88 did not have a *clinical* designation. Within this nonclinical group, median number of total publications and total citations 5 years after ABOS certification were 11.5 (mean, 15.4; SD, 12.3) and 33.5 (mean, 87.5; SD, 130.4), respectively. This group had a median *h*-index of 3 (mean, 3.9; SD, 3.1). Median number of papers published in *CORR* and *JBJS* was 4 (mean, 6.2; SD, 6.2). Median number of papers cited at least 50 times was 2 (mean, 3.2; SD, 4.0). A complete bibliometric summary is detailed in [Tables 1 and 2](#).

Mean certification year was 1989 (range, 1968–2005; SD, 9.1 years). *T* tests revealed that total publications, first-author publications, last-author publications, middle-author publications, total citations, and *h*-indexes were higher ( $P$ s < .001–.004) for those certified after 1995 ( $n = 30$ ) than for those certified before 1990 ( $n = 39$ ) ([Table 3](#)). Scatter plots suggested that early total publications, citations, and *h*-indexes were increasing over time ([Figure](#)).

## DISCUSSION

Publication in the medical literature is an indication of academic productivity. However, there are no data establishing early-career productivity milestones. These data would interest young faculty members aspiring to attain professor status. We conducted the present study to describe the early academic productivity of current professors of orthopedic surgery at elite medical schools.

This study had several limitations. First, using bibliometric analysis to measure merit is admittedly crude, as it fails to capture contributions in nonacademic domains. For some faculty members, achievement in nonclinical areas may be substantial, and indeed the reason for their promotion. Second, the method used here tends to emphasize quantity over quality. Although we attempted to compensate for this bias—by reporting total citations, *h*-indexes, and numbers of *CORR*, *JBJS*, and blockbuster publications—we could not remove it completely. Third, choice of schools was arbitrary. Fourth, the sample included only those who attained professor rank; no data are available for orthopedic surgeons who were once assistant or associate

professors and were not promoted further. Thus, even if number of publications was the sole criterion for promotion, no statement can be made about the likelihood of promotion given a certain number. Meaningful inferences about a candidate's chance for promotion (assuming that the standards have not changed) can be made only with complete data, including "failures."

Despite its limitations, this study provided novel information that can be useful to junior faculty members. Our cohort of orthopedic surgery professors at a select group of schools published 11 papers by year 5 after ABOS certification. A faculty member was the first or last author of 7 of these papers, and 3 papers were published in *CORR* or *JBJS*. Each of the 11 papers was cited almost 30 times, and 2 of the 11 eventually received at least 50 citations each. Faculty members had an *h*-index of about 3 at the 5-year mark. As expected, those who were clinical professors were less academically productive (nevertheless, some had formidable achievements). As schools may have different criteria for various academic titles, it is not possible to generalize across all schools. Of particular importance is the wide range for all data categories, particularly at the low end—buttressing the idea that, at some schools, clinical or teaching work may be sufficient for promotion.

Younger professors demonstrated higher early output than their senior counterparts did, as evidenced by increases in publications of any authorship, citations, and *h*-indexes. However, number of publications in *CORR* and *JBJS* was stagnant, as was number of publications cited more than 50 times. These findings may parallel the proliferation of journals, publications, and citations since the digitization of scientific media. For example, number of orthopedic Medline articles nearly doubled over the period 2000–2010, from 29,471 to 55,074 per year; in addition, number of authors per *JBJS* article increased from 1.6 in 1949 to 5.1 in 2009.<sup>5</sup> This inflationary landscape may impose higher expectations on young faculty members, and, though this report suggests that professor-worthy output is increasing, it makes no effort to predict future milestones. To be sure, the information presented here does not represent a complete assessment of a faculty member's contribution. In addition, standards for promotion will be different in the future than they were in the past. Nevertheless, our study results provide the best available (though imperfect) benchmarks for professor-worthy early productivity.

## KEY INFO

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## DISCUSSION

## FIGURES/TABLES

**Table 1. Early Scholarly Productivity of All Professors of Orthopedic Surgery (N = 108)**

	Median	Mean	SD	Range
Total publications	11	13.9	12.2	0-56
First author	5	6.3	6.1	0-37
Last author	2	2.3	2.5	0-12
Middle author	3	5.3	6.3	0-33
Total citations	29.5	79.1	123.3	0-744
Publications in <i>CORR</i> , <i>JBJS</i>	3	5.5	4.1	0-26
<i>h</i> -Index	3	3.6	3.1	0-13
Papers cited at least 50 times	2	2.9	3.8	0-19

Abbreviations: *CORR*, *Clinical Orthopaedics and Related Research*; *JBJS*, *Journal of Bone and Joint Surgery*.

**Table 2. Early Scholarly Productivity of Professors of Orthopedic Surgery Versus Clinical Professors**

		Professors (N = 88)	Clinical Professors (N = 20)
Total publications	Median	11.5	3.5
	Mean (SD)	15.4 (12.3)	7.6 (9.5)
	Range	0-56	0-34
First author	Median	5	2
	Mean (SD)	7.1 (6.2)	2.9 (3.9)
	Range	0-37	0-15
Last author	Median	2	1
	Mean (SD)	2.5 (2.5)	1.8 (2.4)
	Range	0-12	0-9
Middle author	Median	4	1
	Mean (SD)	5.9 (6.5)	3.0 (4.4)
	Range	0-33	0-16
Total citations	Median	33.5	7
	Mean (SD)	87.5 (130.4)	42.2 (77.5)
	Range	0-744	0-271
Publications in <i>CORR</i> , <i>JBJS</i>	Median	4	1
	Mean (SD)	6.2 (6.2)	2.5 (3.3)
	Range	0-26	0-13
<i>h</i> -Index	Median	3	1
	Mean (SD)	3.9 (3.1)	2.3 (2.8)
	Range	0-13	0-9
Papers cited at least 50 times	Median	2	0.5
	Mean (SD)	3.2 (4.0)	1.6 (2.6)
	Range	0-19	0-10

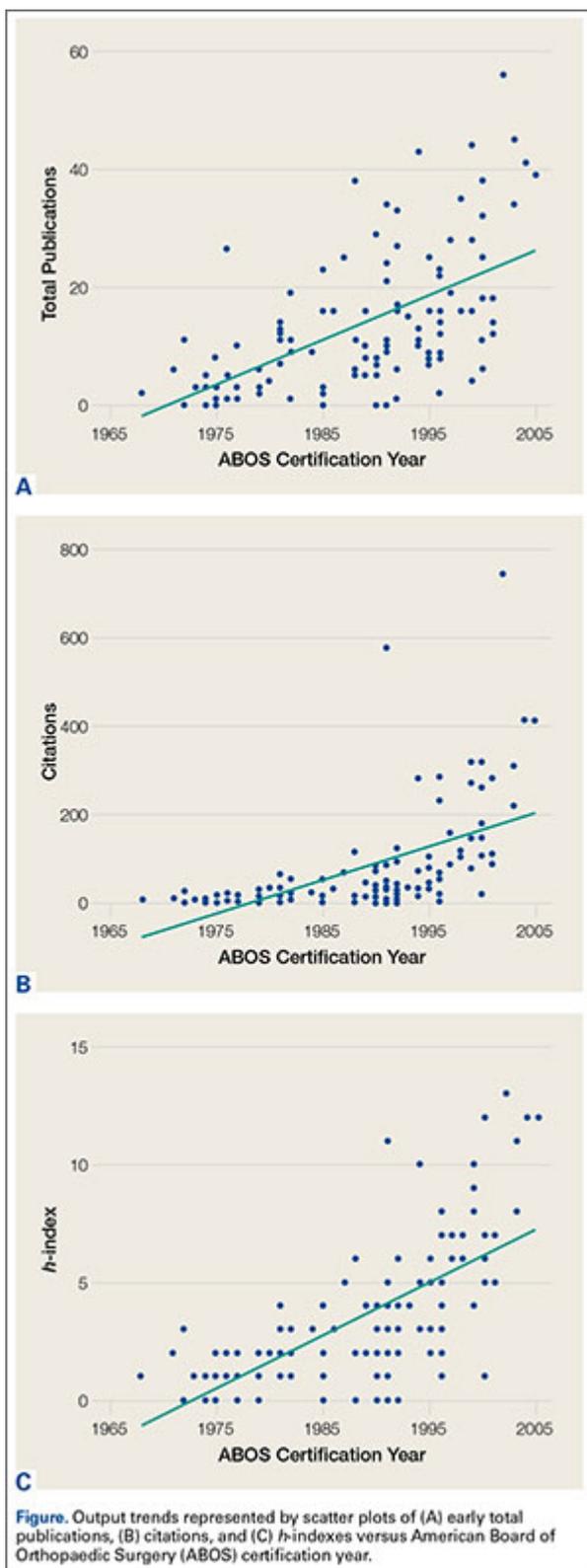
Abbreviations: *CORR*, *Clinical Orthopaedics and Related Research*; *JBJS*, *Journal of Bone and Joint Surgery*.

**Table 3. Early Scholarly Productivity of Professors of Orthopedic Surgery ABOS-Certified Before 1990 Versus After 1995**

		<b>Before 1990 (N = 39)</b>	<b>After 1995 (N = 30)</b>	<b>P</b>
Total publications	Median	7	18	< .001*
	Mean (SD)	9.4 (8.4)	21.8 (13.8)	
	Range	0-38	2-56	
First author	Median	3	9.5	< .001*
	Mean (SD)	4.1 (4.3)	10.1 (7.0)	
	Range	0-19	0-37	
Last author	Median	1	3.5	.001*
	Mean (SD)	1.6 (1.9)	3.6 (2.9)	
	Range	0-8	0-12	
Middle author	Median	2	5	.004*
	Mean (SD)	3.7 (4.4)	8.1 (7.6)	
	Range	0-20	0-33	
Total citations	Median	14	110	< .001*
	Mean (SD)	21.9 (23.8)	171.8 (161.8)	
	Range	0-112	3-744	
Publications in <i>CORR</i> , <i>JBJS</i>	Median	4	5	.2
	Mean (SD)	5.0 (4.8)	6.8 (6.5)	
	Range	0-12	0-25	
<i>h</i> -Index	Median	2	6	< .001*
	Mean (SD)	2.1 (1.3)	6.2 (3.4)	
	Range	0-25	2-29	
Papers cited at least 50 times	Median	1	3	.06
	Mean (SD)	2.2 (2.9)	3.7 (3.4)	
	Range	0-14	0-14	

Abbreviations: ABOS, American Board of Orthopaedic Surgery; *CORR*, *Clinical Orthopaedics and Related Research*; *JBJS*, *Journal of Bone and Joint Surgery*.

\*Statistically significant below threshold of  $P < .006$ .



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