

Orthopaedic Shoulder and Elbow Fellowship Directors in the United States Have Substantial Research Output but Lack Diversity



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Purpose: To investigate the characteristics of shoulder and elbow fellowship directors (FDs). **Methods:** FDs for shoulder and elbow fellowship programs in the United States were identified. Demographic, educational, and professional background data were collected from available curricula vitarum, institutional biographies, and the Scopus database. Data collected included age, sex, race/ethnicity, training locations, graduation years, advanced degrees, current institutional information, and personal research H-index. **Results:** Thirty current orthopaedic shoulder and elbow FDs were identified. The mean Scopus H-index was 25.5. The mean age of FDs was 52.1 years. In total, 29 FDs (96.7%) were male and 1 (3.3%) was female. In addition, 25 of the 30 (83.3%) were White (83.3%), 4 were Asian, and 1 (3.3%) was Hispanic. Two (6.7%) had a military affiliation. Mean time from fellowship training graduation to FD appointment was 13.5 years. Mean number of years as FD was 6.1 years, whereas the number of years tenure with an FD-affiliated institution was 13.0 years. Mean calendar years for completion of orthopaedic residency training and fellowship training were 1998 and 2000, respectively. The residencies that produced the most future FDs were Hospital of the University of Pennsylvania (n = 2) and University of Nebraska Medical Center/Creighton University Health Foundation (n = 2). The fellowship that produced the most future FDs was Columbia University (n = 6). Moderate correlation was found between age and Scopus H-index ($r = 0.48$; $P = .04$) and years as FD and Scopus H-index ($r = 0.42$; $P = .03$). **Conclusions:** Women and minorities are under-represented in leadership positions in shoulder and elbow surgery. Shoulder and elbow FDs have the highest H-index of any subspecialty reported in the orthopaedic literature. Research productivity is an important qualification when considering the characteristics of shoulder and elbow FDs. **Clinical Relevance:** Fellowship directors can have a profound influence on current and future orthopaedic surgeons. It is important to identify the traits that characterize current fellowship directors to have a better understanding of who we choose as leaders in our field.

Over the past 3 decades, the field of orthopaedic surgery has become more specialized.¹ It is possible that this began with the creation of accredited

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fellowship programs by the Accreditation Council for Graduate Medical Education in 1985. Concurrently, there has been a significant rise in the number of surgeons pursuing fellowship training postresidency.¹⁻³ As of 2013, approximately 90% of all orthopaedic surgeons applying for board certification had completed a fellowship. By contrast, in 2003, the number of orthopaedic surgeons having completed fellowship training was only at 76%.⁴ As fellowship training gains more prominence in the field of orthopaedic surgery, fellowship directors (FDs) will have profound influence on current and future orthopaedic surgeons. Serving as major leaders within their field, FDs often possess unique clinical, research, academic, and professional backgrounds.

To further understand the factors that lead to success in orthopaedic surgery, previous analyses have attempted to describe and characterize orthopaedic

applicants and trainees. Such studies have examined diverse topics such as the factors that influence medical students to pursue orthopaedics, the achievements of successful orthopaedic residency applicants, and the selection criteria that orthopaedic residency programs use to select residents for admission.^{2,5-10} However, few studies have characterized the achievements and leadership qualities of leaders within orthopaedic surgery. Of note, an investigation of orthopaedic trauma surgeons performed by Simson et al.¹¹ found that a strong correlation exists between the total number of publications, citations, and H-index and a higher academic rank. In addition, few studies highlight sex and racial disparities present in orthopaedic surgery, along with the potential impacts such disparities have on the field.¹²⁻¹⁴ Other studies have sought to describe the leadership characteristics of plastic surgery and neurosurgery FDs and orthopaedic FDs in adult reconstructive surgery, spine surgery, sports medicine, trauma, foot and ankle surgery, musculoskeletal oncology, and pediatrics.¹⁵⁻²³

Shoulder and elbow orthopaedic FDs possess a diverse repertoire of leadership skills and professional, academic, and clinical achievements. Previous studies have suggested that research productivity metrics such as H-index and institutional training background may play an important part in achieving promotion.^{24,25} However, further investigation of the factors that are associated with these highly accomplished individuals is warranted. The purpose of this study was to investigate the characteristics of shoulder and elbow FDs. Our hypothesis is that sex and racial disparities exist among shoulder and elbow FDs as they do in other surgical specialties and that high research productivity is a key FD characteristic.

Methods

The American Shoulder and Elbow Surgeons (ASES)-recognized list of Shoulder and Elbow Fellowship Programs listing for 2020-2021 was reviewed to compile a list of all Accreditation Council for Graduate Medical Education—accredited shoulder and elbow fellowships in the United States (accessed January 2021).²⁶ This listing from ASES was cross-referenced with the SF Match 2020 fellowship listing to ensure accuracy.²⁷ The FD from each program was identified from the ASES and SF Match shoulder and elbow fellowship listings. Once a list of fellowship programs was finalized, demographic, educational, and professional background data was collected for each FD by review of institutional biographies, publicly available curriculum vitae (CV), or personal websites. If all desired information was not present on institutional/personal websites or a CV, electronically mailed (e-mailed) inquiries were sent to fellowship program administrators or coordinators that

requested the missing pieces of data. If no response was received, the data point was excluded from analysis.

Data collected for each shoulder and elbow FD included the following: age, sex, race/ethnicity, past medical school location, past residency training location, past fellowship training location, residency and fellowship graduation years, additional advanced degrees, military affiliation, institutional loyalty, year hired by current institution, time since residency and fellowship completion until FD appointment, and length of time in FD role. Furthermore, each FD's H-index, total number of publications, and total number of citations were collected in an effort to measure research productivity and impact.

An H-index is an objective measurement of an individual's scientific productivity and impact. H-index is defined as the maximum value of h such that the author in question has published h scientific manuscripts that have all been cited a minimum of h times.²⁸ For example, an author with an H-index of 20 must have 20 published scientific manuscripts all with a minimum of 20 citations each. To obtain the data for H-index, total number of publications, and total number of citations, the FD director's name was searched on the Scopus database (Elsevier BV, Waltham, MA).²⁹ The Scopus database is composed of a vast record of peer-reviewed literature and charts scientific productivity metrics such as H-index, total number of publications, and the total number of citations for authors. Publications were defined as pieces of scientific literature where the author's name was contained anywhere on the author line. The total number of citations were calculated by the Scopus database and defined as the total number of citations in which the author was acknowledged for any of his or her scientific works. In addition, the orthopaedic literature was reviewed for recent reports of sex and racial representation within the field so that the findings of this study could be interpreted within the broader orthopaedic environment.

Statistical analysis included the calculation of Pearson correlation coefficients. Statistical analysis was performed using Excel (Microsoft Corp., Redmond, WA). The correlation coefficients calculated in this analysis were interpreted according to Mukaka's guide on correlation coefficient interpretation in medical research settings.³⁰ Correlation coefficient values <0.3 , 0.3 to ≤ 0.5 , >0.5 to ≤ 0.7 , >0.7 to ≤ 0.9 , and >0.9 are suggestive of low, moderate, high, and very high positive correlation, respectively.

Results

The ASES 2020-2021 Orthopaedic Shoulder and Elbow Fellowship listing reports a total of 30 accredited shoulder and elbow fellowship programs in the United States, all of which are represented in this analysis

Most Commonly Attended Medical Schools



Fig 1. The most commonly attended medical schools among current orthopaedic shoulder and elbow fellowship directors. All medical schools with at least 2 orthopaedic shoulder and elbow fellowship director graduates were included. (FD, fellowship director.)

(100%). The 30 FDs in this analysis had a mean age of 52.1 ± 7.3 years. Furthermore, 29 (96.7%) were male and 1 (3.3%) was female. A total of 5 (16.7%) FDs possessed 1 or more advanced degrees. In regard to military affiliation, 2 (6.7%) had a current or previous military affiliation in their career. The mean Scopus H-index, total number of citations, and total number of publications for all were 25.5 ± 17.6 , $3,232.9 \pm 5,979.9$, and 106.0 ± 97.0 , respectively (Fig 1). The research metrics for the 10 most prolific researchers in this group of FDs are included in Table 1. Regarding the racial and ethnic breakdown of FDs, orthopaedic shoulder and elbow FDs were predominately White (n = 25; 83.3%), followed by Asian (n = 4; 13.3%), and Hispanic (n = 1; 3.3%).

The mean calendar years for the completion of orthopaedic residency training and fellowship training

were 1998 ± 8.3 years and 2000 ± 6.9 years, respectively. On average, it took 13.5 ± 7.5 years from fellowship training graduation until FD appointment. Furthermore, the mean number of years that a FD was employed or affiliated with their current institution was 13.0 ± 7.7 years. Among all FDs, the mean tenure in the FD position was 6.1 ± 3.6 years. All education, research, training, and demographic data is summarized in Table 2.

The top 3 medical schools that educated the most future FDs were Case Western Reserve University School of Medicine (n = 2), Duke University School of Medicine (n = 2), and Northwestern's Feinberg School of Medicine (n = 2). All medical schools that trained at least 2 current FDs were included in Figure 2.

The top 2 orthopaedic residency programs that trained and educated the most future FDs were Hospital

Table 1. Research Metrics for the 10 Most Prolific Orthopaedic Shoulder and Elbow Fellowship Directors as Determined by Scopus H-index, Total Number of Publications, and Total Number of Citations

Fellowship Director's Name	H-index	Total Number of Publications	Total Number of Citations	Fellowship Program Name
Bernard Morrey, M.D.	100	516	33,701	UTHSCSA Shoulder and Elbow Fellowship
William Levine, M.D.	46	171	6,346	Columbia University Medical Center
Mark Frankle, M.D.	40	140	5,646	FOI/FORE Shoulder & Elbow Fellowship
Joaquin Sanchez-Sotelo, M.D., Ph.D.	40	267	5,383	Mayo Clinic Adult Reconstruction Upper Extremity
Thomas Wright, M.D.	38	210	4,676	University of Florida Shoulder and Elbow Fellowship Program
Gregory Nicholson, M.D.	34	132	2,933	Rush University Medical Center, Shoulder and Elbow Fellowship
Lawrence Gulotta, M.D.	32	147	3,376	Hospital for Special Surgery Shoulder Fellowship Program
Patrick Denard, M.D.	31	148	2,925	Oregon Shoulder Fellowship
Andrew Green, M.D.	28	79	2,360	Brown Shoulder and Elbow
Andrew Rokito, M.D.	28	102	2,858	NYU Hospital for Joint Diseases-Shoulder and Elbow

FOI, Florida Orthopaedic Institute; FORE, Foundation for Orthopaedic Research and Education; NYU, New York University; UTHSCSA, University of Texas Health Science Center at San Antonio.

Table 2. The Demographics, Training Background, Education and Employment Progression, and Leadership Positions of Orthopaedic Shoulder and Elbow Fellowship Directors

Overall leadership, n (%)	
Total number of fellowship programs	30
Total number of fellowship directors	30
Demographics, n (%) or mean score \pm SD	
Male	29 (96.7%)
Female	1 (3.3%)
Mean age, y	52.1 \pm 7.3 (n = 27)
Advanced degrees, n (%)	
Ph.D.	1 (3.3%)
M.B.A.	1 (3.3%)
M.P.H.	2 (6.7%)
M.S./M.Ed.	1 (3.3%)
Training and research, n (%) or mean score \pm SD	
Military affiliation	2 (6.7%)
Mean fellowship director Scopus H-index	25.5 \pm 17.6 (n = 30)
Mean number of total citations	3,232.9 \pm 5,979.9 (n = 30)
Mean number of publications	106.0 \pm 97.0 (n = 30)
Race/ethnicity, n (%)	
American Indian or Alaskan Native	0 (0.0%)
Asian	4 (13.3%)
Black or African American	0 (2.3%)
Hispanic or Latino	1 (3.3%)
Native Hawaiian or Other Pacific Islander	0 (0.0%)
White	25 (83.3%)
Education and employment progression, mean score \pm SD	
Mean residency graduation calendar year	1998 \pm 8.3 (n = 25)
Mean fellowship graduation calendar year	2000 \pm 6.9 (n = 24)
Mean number of years from fellowship graduation to fellowship director appointment	13.5 \pm 7.5 (n = 19)
Mean number of years of fellowship director employment at his/her current institution	13.0 \pm 7.7 (n = 23)
Mean number of years in fellowship director role	6.1 \pm 3.6 (n = 19)
Mean number of years from year of hire to year appointed fellowship director	6.6 \pm 6.8 (n = 19)
Institutional loyalty, n (%)	
Fellowship directors currently working at same institution as medical school graduation	2 (6.7%)
Fellowship directors currently working at same institution as residency graduation	10 (33.3%)
Fellowship directors currently working at same institution as fellowship graduation	6 (20.0%)
Correlated H-indices, r (<i>P</i>)	
Years as fellowship director vs Scopus H-index	0.48 (.04)*
Age versus Scopus H-index	0.42 (.03)*

SD, standard deviation.

*Indicates correlation is significant.

of the University of Pennsylvania (n = 2) and University of Nebraska Medical Center/Creighton University Health Foundation (n = 2). All orthopaedic residency programs that trained at least 2 current FDs were included in [Figure 3](#).

The top 4 orthopaedic shoulder and elbow fellowship programs that trained and educated the most future FDs were Columbia University Medical Center Shoulder and Elbow Fellowship (n = 6), Mayo Clinic Upper Extremity Fellowship (n = 5), California Pacific Medical Center Shoulder and Elbow Fellowship (n = 2), and Washington University Shoulder and Elbow Fellowship (n = 2). All orthopaedic fellowship programs that trained at least two current FDs were included in [Figure 4](#).

Pertaining to institutional loyalty, 2 (6.7%) FDs are currently serving as directors of fellowship programs affiliated with the medical school they attended. Furthermore, 10 FDs (33.3%) are currently fellowship directors at institutions affiliated with the training program in which they completed their residency. To continue, 6 FDs (20.0%) are currently directing the orthopaedic shoulder and elbow fellowship program where they received their own fellowship training.

Pearson correlation coefficient calculations displayed a statistically significant moderate correlation between age and Scopus H-index (r = 0.48; *P* = .04). Similarly, the relationship between years as FD and Scopus H-index was also a statistically significant moderate correlation (r = 0.42; *P* = .03).

Most Commonly Attended Residency Training Institutions

Fig 2. The most commonly attended orthopaedic surgery residency programs among orthopaedic shoulder and elbow fellowship directors. All residency programs with at least 2 orthopaedic shoulder and elbow fellowship director graduates were included. (FD, fellowship director.)



Discussion

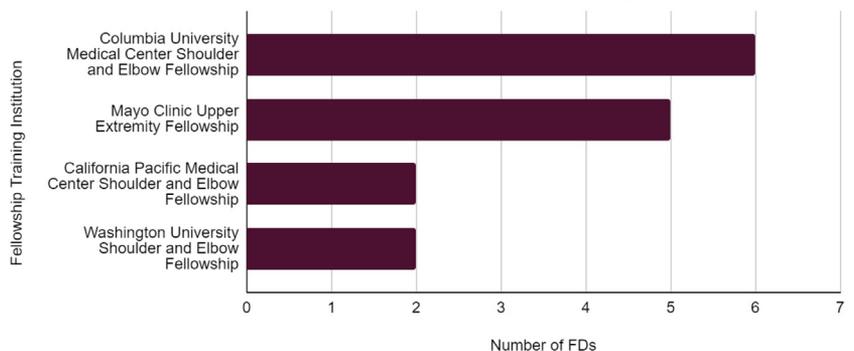
Shoulder and elbow fellowship directors are predominantly White men in their early 50s, with minimal female and minority representation. Furthermore, shoulder and elbow surgeons are distinguished with their extensive research backgrounds and portfolios, having the highest H-index of any subspecialty reported in the orthopaedic literature. Notwithstanding a significant increase in diversity of medical school graduates and residents in recent years, this study reveals results analogous to those previously described regarding the percentage of women and minority ethnic groups occupying academic leadership positions in the field of surgery. Of the 30 fellowship positions identified in this study, only 3.3% (1) were female and 16.7% (5) reported themselves as non-White. Recent studies indicated that orthopaedic sports medicine and spine surgery fellowship directors represented women similarly, with 1.1% and 4.0%, respectively.^{16,20} Orthopaedic sports medicine fellowship directors were reported as 87.8% White, compared with 83.3% in the present study. Overall, FDs in orthopaedic shoulder and elbow surgery are predominantly White males.

While women have constituted the majority of United States medical school classes since 2017 and the percentage of under-represented minorities (URMs)

attending medical school has steadily increased, significant and consistent change is needed to address current disparities in leadership.³¹ Among the factors driving this disparity is that orthopaedic surgery continues to suffer a perpetual pipeline shortage of female and URM medical school graduates entering residency programs and, naturally, fellowship positions and subsequent leadership. As of the 2016-2017 academic year, orthopaedic surgery ranked lowest of all medical specialties in the proportion of female residents at 14.0%.³² This same study found that women represent 17.8% of full-time orthopaedic surgery faculty at United States medical schools, the lowest of all other specialties. A recent study found that African Americans and Hispanics represented only 4% and 5% of current orthopaedic trainees, respectively. While our study does not explain why these differences in diversity exist in the field of orthopaedic surgery, creative and effective initiatives can help improve diversity. One way this pipeline shortage can be addressed is through effective mentoring.^{33,34} Formal and informal mentoring relationships can be offered and extended to under-represented groups from the premedical years, in medical school, and then into training. For example, the J. Robert Gladden Orthopaedic Society provides mentoring programs for URM trainees, and the Ruth

Most Commonly Attended Fellowship Training Institutions

Fig 3. The most commonly attended orthopaedic shoulder and elbow fellowship programs among orthopaedic shoulder and elbow fellowship directors. All fellowship programs with at least 2 orthopaedic shoulder and elbow fellowship director graduates were included. (FD, fellowship director.)



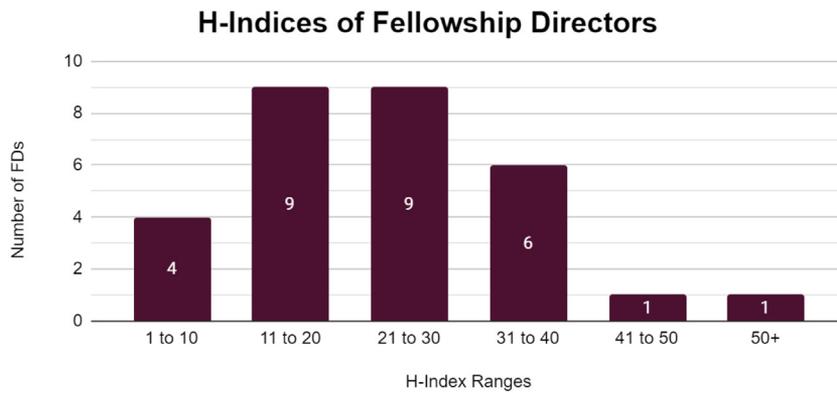


Fig 4. An illustration of the Scopus h-indices for all orthopaedic shoulder and elbow fellowship directors. The Scopus H-index values are as of January 1, 2021. (FD, fellowship director.)

Jackson Orthopaedic Society provides mentoring for women. Guiding students, especially women and those who are historically URM in orthopaedic surgery, could help increase diversity in orthopaedic leadership.³⁵ Such programs may remedy the substantially lower odds of admission into orthopaedic residency that minority applicants experience when accounting for academic performance metrics.³⁶

This study demonstrated that orthopaedic shoulder and elbow fellowship directors are predominantly White men in their early 50s. These leaders are characterized by robust research backgrounds and similar training pedigrees. Regarding training pedigree, the institution at which shoulder and elbow FDs received their fellowship training played a significant role in FD appointment. In fact, more than one third of shoulder and elbow FDs received their fellowship training from 2 institutions: Columbia University Medical Center Shoulder and Elbow Fellowship and the Mayo Clinic Upper Extremity Fellowship. In contrast, residency training and medical education showed weaker associations, failing to display a similar relationship in terms of a select number of institutions producing a significant portion of fellowship directors. Factors such as expansive networking opportunities, expansive research opportunities and production, and institutional legacy, and connections with leaders specifically within shoulder and elbow surgery may contribute to the success these institutions have in producing FDs.

Regarding research, orthopaedic shoulder and elbow FDs are distinguished by their research productivity in terms of total number of citations, total number of publications, and H-indices. Specifically, shoulder and elbow fellowship directors possessed a mean H-index of 25.5, mean total number of citations number of 3,232.9, and an average of 106 publications. In comparison to previous studies that highlighted the research productivity of FDs in orthopaedics, shoulder and elbow surgeons possessed similar and higher research metrics. For example, regarding H-indices, shoulder and elbow FDs' average H-index of 25.5 was

higher than that of fellowship directors in adult reconstruction (16.5), spine (23.8), sports medicine (22.5), trauma (15.1), musculoskeletal oncology (21.6), foot and ankle (13.3), and pediatrics (17.2).¹⁵⁻²¹ For comparison, Bastian et al.³⁷ reported in 2017 on academic orthopaedic surgery research productivity for assistant professors (3.6), associate professors (8.4), professors (15.1), and chairs (17.8). Strong research portfolios of shoulder and elbow FDs in comparison to leaders within orthopaedics suggests that established research and academic backgrounds contribute to institutional progression. Furthermore, as leaders within orthopaedics, FDs benefit tremendously from contributing to the advancements in such an innovating field, as they train the next generation of physicians.

Study Limitations

The limitations of this study pertain primarily to data collection. First of all, the data-collection process was dependent on accessing and retrieving self-reported data online. Thus, information reported on a CV or institutional biography could possibly be outdated at the time of data retrieval. Researchers attempted to limit such discrepancies by authenticating data using multiple sources, resolving unclear data via emails to fellowship program administrators, and using information from nonpublicly editable resources. Unsuccessful attempts of contacting fellowship administrators resulted in select gaps in the data. Finally, data in this study represent a cross-sectional representation of shoulder and elbow FDs at one point in time. Despite these limitations, 100% of FDs in the United States were included in this study and the findings provide an up-to-date snapshot of objective factors regarding FDs in shoulder and elbow surgery.

Conclusions

Women and minorities are under-represented in leadership positions in shoulder and elbow surgery. Shoulder and elbow FDs have the highest H-index of

any subspecialty reported in the orthopaedic literature. Research productivity is an important qualification when considering the characteristics of shoulder and elbow FDs.

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