

## Research Article

# Orthopedic Sub-Specialties Vary in Representation of Female Fellowship Program Directors

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### Background

Female representation varies among subspecialties as far as existing surgeons and entry of female candidates. Mentorship has been identified as a factor affecting women's decision to choose a sub-specialty. Orthopaedic fellowship program director gender is an important factor for female applicants in choosing a subspecialty has not been analyzed.

### Purpose

To report on fellowship program director (PD) genders within orthopedic subspecialties and quantify the number of training positions represented by female PDs. Also, to compare the academic ranks and h-indices, of male and female PDs within each specialty.

### Methods

Data was collected by utilizing the San Francisco Match program data, subspecialty program lists, and specific fellowship pages. For each subspecialty, we calculated the percentage of fellowship program and fellowship positions led by female program directors. We compared academic ranks and h-indices between male and female program directors. Statistical significance was defined as a P-value of <0.05.

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In 2022, Dr. Cannada received what she considers the two biggest honors of her career. The Ruth Jackson Orthopaedic Society awarded her the inaugural "She for She" award given to a person who supports and elevates others. The Orthopaedic Trauma Association awarded her the first OTA DEI and Health Disparities Leadership Award in October 2022. She is honored and humbled to lead by example.

She has over 200 publications and 250 presentations at national meetings. She could not do all this without the loving support of her husband Jeff and daughter Annalise and her parents, Theresa Metcalf and the late Dr. John Metcalf.

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## Results

Female program directors led 4.7% of programs and 3.4% of fellowship positions. Female leadership varied by subspecialties, highest in orthopedic oncology (20% programs, 18.5% positions) and pediatric orthopedics (13.3% program, 9.6% positions). Lowest female representation in sports (2.2% programs, 1.2% positions) and joints (0.9% programs, 0.5% positions). Female fellowship PDs were more likely to be assistant professors than their male counterparts (39% vs. 22%), and less likely to be full professors (17% vs. 33%), but these differences were not statistically significant ( $P=0.13$ ). In the 6 subspecialties for which an H-index was calculated, 5/6 subspecialties there was not significant difference in h-indices.

## Conclusion

Women remain underrepresented in the roles as orthopedic fellowship program directors there is significant variation amongst the subspecialties. Female program directors did not have a significantly different academic rank and H-index did not differ significantly by program director gender in 5/6 subspecialties.

## INTRODUCTION

Orthopedics remains the medical specialty with the lowest percentage of female physicians. As of 2019, 36.3% of actively practicing US physicians were female and only 5.8% of practicing orthopedic surgeons were female. Similarly, in 2019 women made up 45.8% of residents and fellows in ACGME-accredited programs, but orthopedics again had the lowest percentage at 12.9%.

As a demographic group, female orthopedic surgeons are unevenly distributed within the nine orthopedic subspecialties. A recent survey-based study of 288 practicing female orthopedists, fellows, and fellowship-match residents identified subspecialty practices as 24% hand, 22.6% pediatrics, 16.3% sports, 8.7% arthroplasty, 8.3% trauma and foot and ankle, 7.7% general practice, 7.6% oncology, 4.5% pediatric spine, 3.1% adult spine, and 2.4% shoulder and elbow. Regarding why they chose their subspecialty, it was found the respondents ranked mentorship as the highest extrinsic influencing factor. Female applicants continue to enter the subspecialties at unequal rates. As of 2014, pediatric orthopedics had the highest percentage of female applicants at 25%, with foot and ankle second (14%), shoulder and elbow third (10%), sports and trauma tied for fourth (9%), tumor and arthroplasty tied for 6th (6%), and spine last (at a mere 3%).

It is not clear what other factors may be driving this uneven dispersal. Since mentorship can be a crucial factor, one wonders if having female fellowship program directors would influence choices. To date, no one has reported on data regarding orthopaedic fellowship program director genders, a potentially important factor for female applicants in choosing a subspecialty. The goals of this study were therefore 1) to report on fellowship program director (PD) genders within eight orthopedic subspecialties, 2) to quantify the number of training positions represented by female PDs in each subspecialty, 3) to compare the academic ranks of male and female PDs within each specialty, and 4) to compare the h-indices, a quantitative score of research productivity and impact, of male and female PDs. This study was aimed at a previously underreported area of leadership within the field of orthopedics. We hypothe-

sized that PD gender ratios per subspecialty would mirror those of matriculating fellows. We also hypothesized, based on the mean younger age of female orthopedic surgeons compared to their male counterparts, that female PDs were more likely to be Assistant Professors and to have lower h-indices.

## MATERIALS AND METHODS

We collected data on orthopedic fellowships accepting applicants for the 2023-24 cycle. This was done for the eight orthopedic sub-specialties which utilize the SF Match system (<https://sfmatch.org>), which include adult reconstructive orthopedics and arthroplasty, orthopedic oncology, foot and ankle surgery, shoulder and elbow surgery, pediatric orthopedics, sports medicine, spine surgery, and orthopedic trauma. Hand surgery was excluded due to the applicant pool consisting of orthopedic, general surgery, and plastic surgery trainees and the match occurring through the NRMP. For each of the eight included subspecialties, active fellowship programs were identified through the subspecialty society links on the SF Match Website, which contained program lists. For arthroplasty, these included the American Association of Hip and Knee Surgeons website, the Hip Society Website, and the Knee Society Website. For orthopedic oncology, they included the American Association of Hip and Knee Surgeons website and the Musculoskeletal Tumor Society website. For foot and ankle surgery, they included the American Orthopaedic Foot and Ankle Society website. For pediatric orthopedics, they included the Pediatric Orthopaedic Society of North America website. For shoulder and elbow surgery, they included the American Shoulder and Elbow Surgeons website. For sports medicine, they included the American Orthopaedic Society for Sports Medicine website and the Arthroscopy Association of North America website. For spine surgery, they included the North American Spine Society website. For orthopedic trauma, they included the Orthopaedic Trauma Association website. Individual fellowship websites were used to confirm current program director and number of fellowship positions offered. When questions arose, we emailed the administrator for a given program to clarify.



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Program director gender was determined by the pronouns used on university- or practice-affiliated webpages or the fellowship page. Academic rank was determined in a similar manner, with additional use of Doximity (<https://www.doximity.com/>) and LinkedIn (<https://www.linkedin.com/>) profiles when academic rank was not specified elsewhere. Each PD's H-index was found by searching for their name and current or prior affiliations on Scopus online database (Elsevier BV, Waltham, MA). The H-index is a numerical value meant to quantify research productivity through a composite of number of publications and citations per publication.

While here we are studying gender, i.e. a variable social construct with associated norms (WHO definition) and not sex, i.e. genotype, we use the terms female and male throughout this manuscript as these are the terms used in the majority of previously published works.

Analysis was performed to generate descriptive and comparative statistics. For each orthopedic sub-specialty, descriptive statistics included the number of programs, number of available positions, number of programs with female PDs, and number of fellowship positions led by female PDs. For example, if there were two programs with female PDs and each program had two fellowship positions, this would represent four positions led by female PDs. Comparative statistics entailed 2-sides Student's t-test for all numeric variables and Chi-squared test for all categorical variables. Statistical significance was defined as a P-value of <0.05.

## RESULTS

For orthopaedic fellowships overall, 4.7% of programs had a female program director. This represented leadership for 3.4% of all fellowship positions. The subspecialties ranked by highest to lowest percentage of programs led by women were 1) orthopedic oncology 2) pediatric orthopedics 3) orthopedic trauma 4) foot and ankle 5) shoulder and elbow 6) spine 7) sports 8) joints ([table 1](#)).

The subspecialties ranked by highest to lower percentage of fellowship positions led by a female program director

were 1) orthopedic oncology 2) pediatric orthopedics 3) foot and ankle 4) orthopedic trauma 5) shoulder and elbow 6) spine 7) sports 8) joints ([table 1](#)).

Regarding academic rank, female fellowship PDs were more likely to be assistant professors than their male counterparts (39% vs. 22%), and less likely to be full professors (17% vs. 33%). However, the differences in academic rank between the genders were not statistically significant ( $P=0.13$ ) ([table 2](#)). The percentage of female PDs who had an academic appointment also did not differ significantly from the percentage of male PDs with an academic appointment (87% vs. 78%,  $P=0.32$ ).

H-indices did not differ significantly between male and female PDs for orthopedic trauma, orthopedic oncology, sports, foot and ankle, or spine. For pediatric orthopedics, the h-index was significantly higher for male PDs compared to female PDs ( $17.5 \pm 11.8$  vs.  $6.3 \pm 4.9$ ,  $P=0.028$ ). P-values could not be calculated for shoulder and elbow and arthroplasty as each only had one female PD ([table 3](#)).

## DISCUSSION

We found a low rate of female orthopedic fellowship leadership across the subspecialties, representing 4.7% of all programs and 3.4% of all positions. The percentage of programs and percentage of training positions respectively represented by female program directors was highest in oncology, pediatrics, foot and ankle, and trauma. It was lowest in arthroplasty, sports, and spine. Female program directors were more likely to be Assistant or Associate Professors, while their male counterparts were more likely to be Professors or lack an academic affiliation, though these differences were not statistically significant. Despite on average having a lower academic rank, the h-index amongst the PDs was not significantly different between females and males in 5/6 of the subspecialties where it could be calculated.

The order from highest to lowest percentage female PDs diverged from reported percentages of female applicants to the orthopedic subspecialties from 2010-14, where women represented 25% of pediatrics applicants, 14% for foot and



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**Table 1. Orthopedic Fellowship Programs and Positions, by Subspecialty**

	Trauma	Oncology	Sports	Pediatrics	F+A	S+E	Arthroplasty	Spine	All
2021 Programs	65	20	93	45	49	33	108	77	490
2021 Positions	98	27	242	73	79	43	206	144	912
Programs									
# Lead by Women	4	4	2	6	3	1	1	2	23
% Lead by Women	6.2%	20.0%	2.2%	13.3%	6.1%	3.0%	0.9%	2.6%	4.7%
Positions									
# Lead by Women	5	5	3	7	6	1	1	3	31
% Lead by Women	5.1%	18.5%	1.2%	9.6%	7.6%	2.3%	0.5%	2.1%	3.4%

**Table 2. Academic Ranks of Orthopedic Fellowship Program Directors by Gender**

	Male				Female			
	Assistant	Associate	Professor	N/A	Assistant	Associate	Professor	N/A
Trauma	13	13	28	7	1	1	1	1
Oncology	5	5	6	0	0	2	2	0
Sports	12	26	31	28	1	0	0	1
Pediatrics	12	12	14	3	3	3	0	0
Foot and Ankle	15	11	10	13	1	0	1	1
Shoulder and Elbow	5	11	13	16	1	0	0	0
Arthroplasty	31	22	23	32	1	0	0	0
Spine	19	18	41	11	1	1	0	0
Total (% by Gender)	112(22%)	118 (23%)	166 (33%)	110 (22%)	9 (39%)	7 (30%)	4 (17%)	3 (13%)

**Table 3. Research H-Index of Orthopedic Fellowship Program Directors by Gender and Specialty**

	Male		Female		All		P
	Mean	Median	Mean	Median	Mean	Median	
Trauma	19.7 (13.8)	18	9.3 (3.5)	8	19.0 (13.7)	16	0.14
Oncology	24.2 (16.0)	21	22.5 (9.4)	21.5	23.9 (14.9)	21	0.84
Sports	24.4 (17.3)	22	18 (2)	18	24.3 (17.2)	21	0.60
Pediatrics	17.5 (11.8)	15	6.3 (4.9)	3.5	16.0 (11.8)	14	0.028
Foot and Ankle	14.4 (8.0)	14	17 (14.5)	11	14.5 (8.6)	14	0.62
Shoulder and Elbow	25.8 (17.8)	22	27 (0)	27	25.8 (17.6)	22	x
Arthroplasty	17.8 (16.0)	13	10 (0)	10	17.8 (15.9)	13	x
Spine	25.0 (19.8)	19	8.5 (2.5)	8.5	24.6 (19.7)	19	0.24

ankle, 10% for shoulder & elbow, 9% for sports, 9% for trauma, 6% for arthroplasty/oncology, and 3% for spine. These differences are most notable in shoulder & elbow, sports, and arthroplasty fellowship leadership. It is interesting that sports has the second-lowest percentage of female fellowship directors, given this has previously been

reported as a top three or four subspecialty choice among graduating female orthopedic residents. There was also a significant increase in the proportion of female fellows in sports medicine from 2006 to 2012. Fellowship program directors are promoted to their positions a mean of ten years after graduating fellowship. Given it is a decade later, it is

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not clear why there hasn't been a proportional increase in the number of female program directors within sports.

The reasons for the under-representation of women as fellowship program directors are not clear. However, differences in promotion between male and female physicians and surgeons have been well reported. Hunter et al analyzed multiple surgical specialties across Canada, finding men held leadership positions in higher proportions; 0.32 of all men held a leadership position vs. 0.26 of all women,  $P=0.002$ . Further, regression modeling to account for qualifications such as additional advanced degrees showed women were less likely to be at the highest levels of leadership such as department chair or section head (OR 0.372, 95% CI: 0.216–0.641). Of particular note, this study found the surgical specialties with more women in educational roles had higher percentages of female residents ( $P=0.046$ ). Richter et al looked at rates of promotion of female physicians over time by comparing two cohorts of medical school graduates: those from 1979–1997, and those from 1998–2013, by looking at academic faculty data through 2018. They found fewer women than expected were promoted to associate or full professor or department chair. Importantly, they did not find these differences decreased over time, and actually found the differences in promotion to full professor increased over time [Richter 2020]. Fellowship program directors have a powerful role in shaping the landscape of orthopedic surgery. They interface with trainees in the period where they are securing their first attending position and making the practice setting decisions that come with it. There should be an active effort to train and promote females as fellowship directors and strong role models for improving gender diversity in orthopaedics.

Bratescu et al posited that continued asymmetry in subspecialty selection by female residents could be partially attributed to availability of mentorship. Hence, women historically pursued hand and pediatric orthopedics, and therefore continue to do so. While mentors do not need to be the same gender as mentees, multiple studies have shown that mentorship, or lack thereof, is a strong factor in many applicants' decisions to join a given field. This is an additional identified factor which may perpetuate areas of female under-representation within all levels of orthopedics, including in leadership positions such as fellowship program directors.

Baldwin et al found a significant difference between male and female medical students in response to the question, "Is it more difficult for a woman to be promoted in orthopedic surgery?". Following their educational exposure to orthopedics, 91.7% of women responded yes to this question, an increase from the 82.8% before the intervention. Another study from the UK found only 24% of surveyed female medical students would consider careers in orthopedics, with male field dominance and exposure to negative attitudes regarding female surgeons as listed factors. In order to change these attitudes, it is important for our field to strive toward parity of opportunities for all orthopedists, regardless of gender, sex, race, sexuality, religion, disability status, or any other inherent characteristic.

This study has some notable limitations. We did not include the subspecialty of hand in our analysis, for the reasons stated in the methods section, though it has significantly more women than general orthopedics. Additionally, the h-index is a difficult-to-interpret metric which 1) typically continues to increase with time since publication as articles accumulate citations, 2) does not take into account an author's position (first author, senior author, etc.) on a paper, and 3) does not control for the scientific impact or originality of a paper (i.e. review papers are often cited more than original research). Therefore, it should be interpreted with caution. Further, we did not have access to years in practice of program directors for this study. Given demographic trends in orthopedics, the female programs directors were likely fewer years into practice than their male counterparts, which would make both h-index and academic rank status less accurate head-to-head comparisons.

## CONCLUSION

Overall, women remain underrepresented in the roles of orthopedic fellowship program directors. However, there is a large range amongst the orthopedic sub-specialties. Orthopedic oncology and pediatric orthopedics having the most female fellowship program directors, while sports and joints have the fewest. Female program directors are more often assistant professors than their male peers, who more often do not have an academic appointment. In 5/6 ana-

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lyzed subspecialties, H-indices did not differ significantly  
by program director gender.

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