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Gender Diversity in Orthopaedic Surgery Residencies Does Not Translate to Accreditation Council for Graduate Medical Education–Accredited Fellowships

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Investigation performed at The University of Arizona, Tucson, Arizona

Introduction: Gender representation among orthopaedic surgery applicants and residents has increased over the past two decades. The aims of this study were to evaluate trends of female fellows in ACGME-accredited orthopaedic subspecialties between 2007 and 2021, and to compare the fellowship trends of female representation to those of ACGME-accredited orthopaedic residencies.

Methods: We conducted a retrospective review of publicly available ACGME-accredited fellowship demographic data from 2007 to 2021. The distribution of genders (male vs. female) across subspecialties and orthopaedic surgery residency programs was compared. Chi-square, Spearman correlation, and logistic regression tests were performed to analyze the relationships between year, gender, and fellowship.

Results: Chi-square analysis demonstrated a significant relationship between gender and year for orthopaedic residency ($p < 0.001$), but not for any fellowship. There was a significant negative Spearman correlation between the two variables for hand ($r(1844) = -0.06$, $p = 0.02$) and sports medicine ($r(2804) = -0.05$, $p = 0.01$) fellowships. The negative Spearman correlation for pediatrics ($r(499) = -0.09$, $p = 0.054$) approached but did not reach statistical significance. Logistic regression analysis revealed that, holding year constant and comparing to orthopaedic residency, the odds of male participation increased by 173% (95% CI, 1.8–4.1) in spine, increased by 138% (95% CI, 1.7–3.3) in adult reconstruction, increased by 51% (95% CI, 1.3–1.7) in sports medicine, decreased by 41% (95% CI, 0.5–0.7) in hand, decreased by 36% (95% CI, 0.5–0.9) in foot and ankle, decreased by 48% (95% CI, 0.4–0.7) in musculoskeletal oncology, and decreased by 68% (95% CI, 0.3–0.4) in pediatrics.

continued

There was no formal consent, informed consent, institutional review board approval, or ethical committee approval required for and/or applicable to this type of study because it did not require active human or animal participants.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSOA/A626).

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Conclusion: Although the percentage of female orthopaedic residents in ACGME-accredited programs increased significantly from 2007 to 2021, this has not translated to ACGME-accredited fellowship positions. Future research optimizing methods to improve the representation of females in orthopaedic surgery should be considered.
Level of Evidence: III

Introduction

Approximately 54% of all first-year medical students are female[1]. Equal gender representation has not been reflected in historically male-dominated surgical fields, such as orthopaedic surgery[2]. Compared with all other subspecialties, orthopaedic surgery has consistently demonstrated the lowest percentage of female residents over the past decade, totaling 16% in 2020[3].

In 2019, 19% of the medical students applying to Accreditation Council for Graduate Medical Education (ACGME)-accredited orthopaedic surgery residency programs were female, which was significantly disproportionate to the 15% of female residents who matriculated during that same year[4]. When accounting for females in both residency and fellowship positions during the same year, this proportion further drops to 13%[5,6]. However, the current literature evaluating the gender diversity between residency and fellowship positions is sparse[7,8].

The aims of this study were to (1) evaluate trends of female fellows in ACGME-accredited orthopaedic subspecialties between 2007 and 2021 and (2) compare the fellowship trends of female representation to those of ACGME-accredited orthopaedic residencies. Recruitment and retention of females within orthopaedic surgery continue to be critical if the objective remains for physician demographics to resemble those of the populations they serve.

Methods

We performed a retrospective review of orthopaedic surgery demographic data from 2007 to 2021 as published in the online ACGME Data Resource Book series[6]. Institutional Review Board approval was not required, given the public and anonymous nature of the data set provided by the ACGME. Our study evaluated gender demographics (male vs female) of orthopaedic residents, as well as fellows in adult reconstruction, foot and ankle, hand, sports medicine, musculoskeletal oncology, spine, trauma, and pediatrics. Shoulder and elbow fellowship data were not available in the data set. The Statistical Package for the Social Sciences software was used for data analysis. The Pearson χ^2 test of independence was used to test for association. Logistic regression was used to analyze the relationship between year, fellowship, orthopaedic residency, and gender. A Spearman test was used to assess correlation of values. The level of significance was set at $p < 0.05$.

Results

There were a total of 2,320 ACGME-accredited orthopaedic surgery residency and fellowship program cohorts (Figs. 1 and 2) containing 51,856 active trainees between 2007 and 2021, but 1,935 of these individuals did not choose to self-identify as male or female. We included the remaining 49,921 residents and fellows, of which 42,756 were males (Fig. 3) and 7,165 were females (Fig. 4).

A χ^2 test was performed to examine the relationship between gender and year (2007-2021) in orthopaedic residency and each subspecialty fellowship. The relationship between these variables was not significant for any fellowship but was significant for orthopaedic residency positions ($p < 0.001$). Pearson χ^2 values for each specialty and the total number of filled positions are included in Table I.

Spearman correlation was computed to assess the relationship between the number of males (Fig. 3) and females (Fig. 4) within orthopaedic residency and each subspecialty fellowship between 2007 and 2021. There was a significant negative correlation between the 2 variables for hand (r [1,844] = −0.06, p = 0.02) and sports medicine (r [2,804] = −0.05, p = 0.01) fellowships. The negative correlation for pediatrics (r [499] = −0.09, p = 0.054) approached but did not reach statistical significance. Spearman correlation results are reported in Table II.

Logistic regression analysis was used to analyze the relationship between year, fellowship, orthopaedic residency, and gender. Holding year constant and comparing with orthopaedic residency, the odds of male participation increased by 173% (95% CI [1.8-4.1]) in spine, increased by 138% (95% CI [1.7-3.3]) in adult reconstruction, increased by 51% (95% CI [1.3-1.7]) in sports medicine, decreased by 41% (95% CI [0.5-0.7]) in hand, decreased by 36% (95% CI [0.5-0.9]) in foot and ankle, decreased by 48% (95% CI [0.4-0.7]) in musculoskeletal oncology, and decreased by 68% (95% CI [0.3-0.4]) in pediatrics. There were no significantly different odds of male representation between trauma and orthopaedic residency (95% CI [0.7-1.4]). Odds ratios and associated confidence intervals are reported in Table III. When fellowship and residency were held constant, the odds of male representation decreased by 3% (95% CI [0.97-0.98]) for each year.

The range of percentages of female trainees in each subspecialty from the years 2007 to 2021 is included to assist as a reference point (Table IV).

Discussion

The principal finding of our study is that although the percentage of female orthopaedic residents in ACGME-accredited programs increased significantly from 2007 to 2021, the number of female fellows among every subspecialty did not demonstrate any significant changes during this same time. This highlights that despite recruitment of more females to orthopaedic surgery residency programs, this has not translated to ACGME-accredited fellowship positions.

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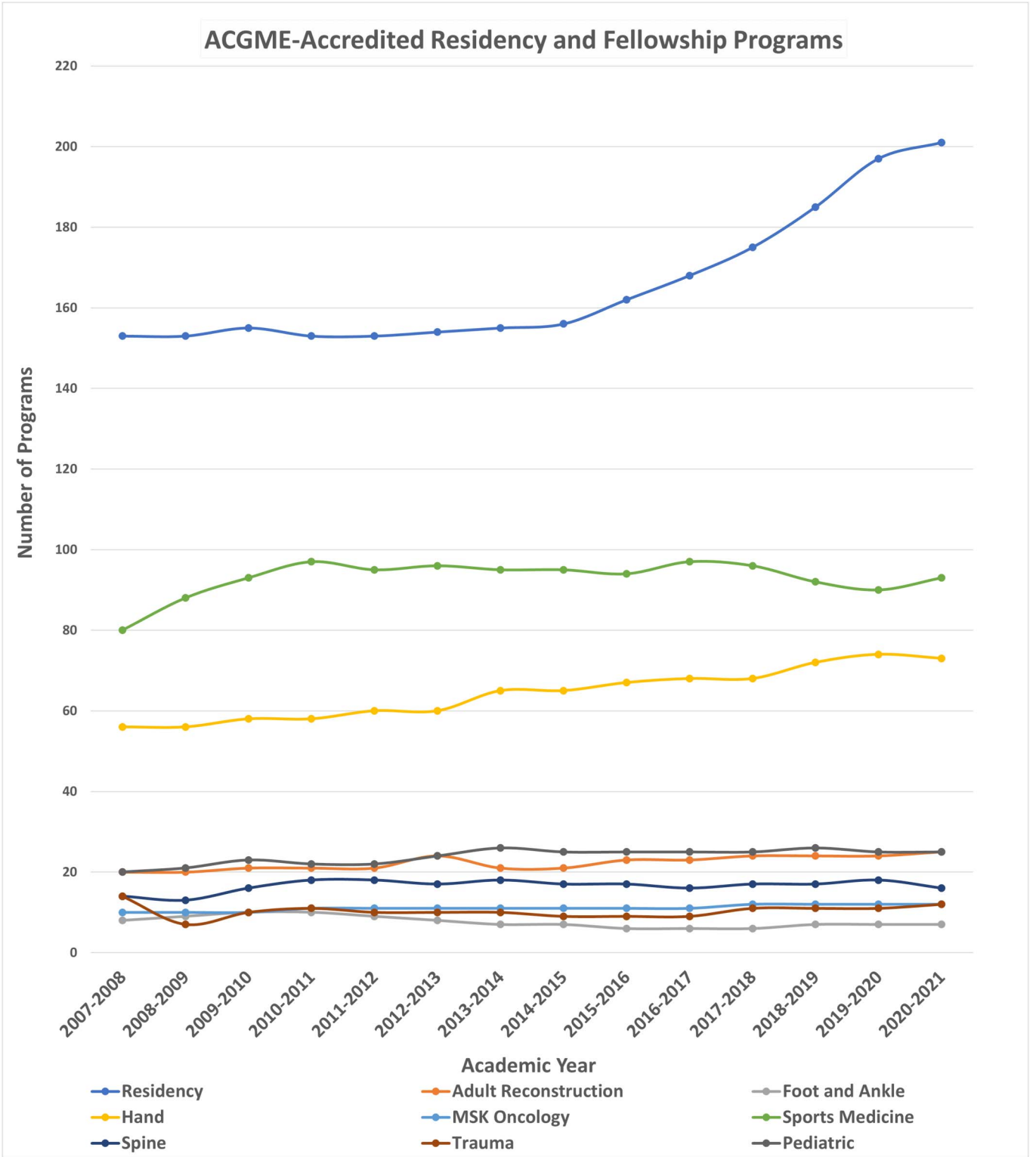

Fig. 1

The number of ACGME-accredited orthopaedic surgery residency and fellowship programs from 2007 to 2021. ACGME = Accreditation Council for Graduate Medical Education.

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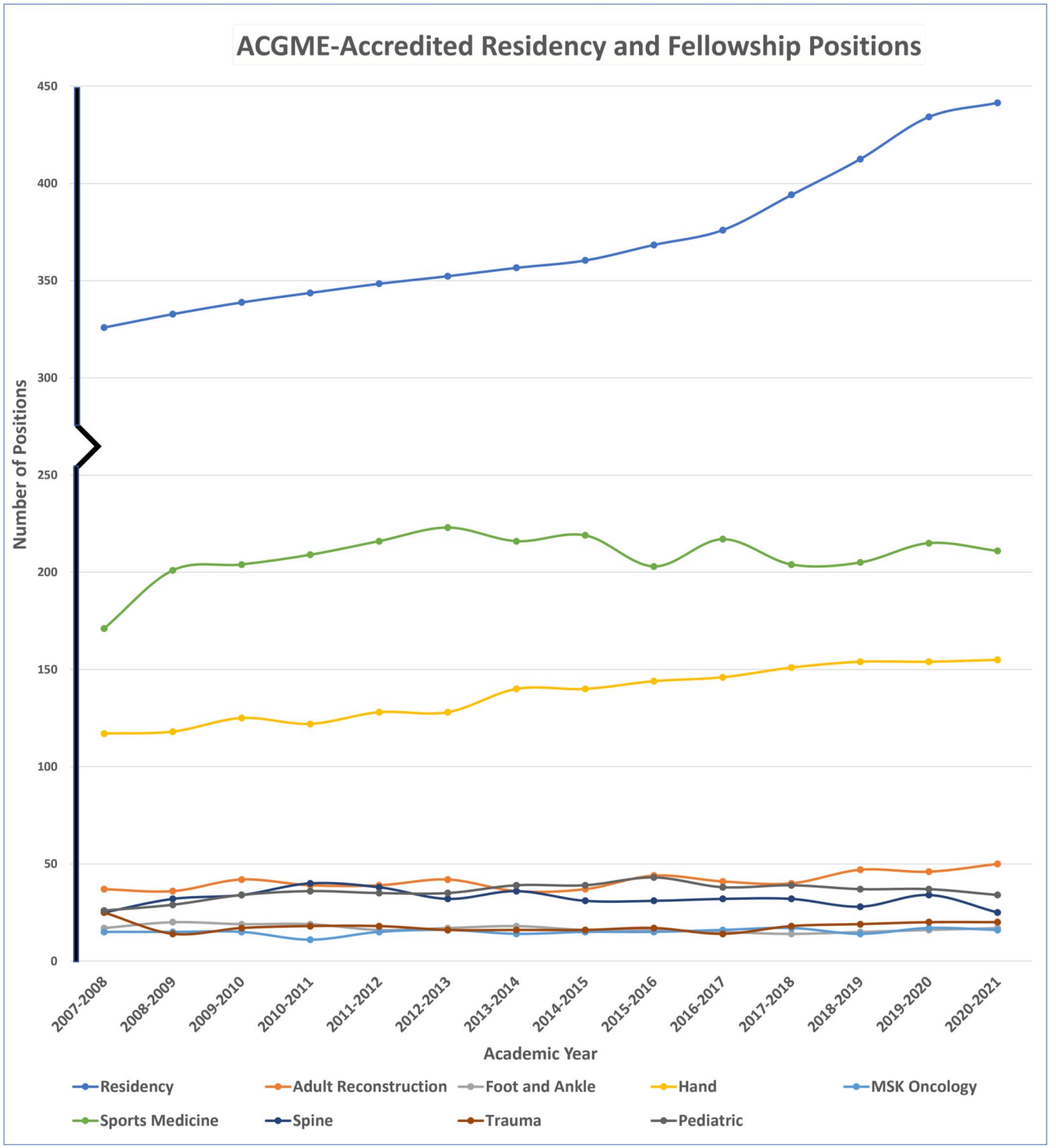

Fig. 2

The number of ACGME-accredited orthopaedic surgery residency and fellowship positions from 2007 to 2021. ACGME = Accreditation Council for Graduate Medical Education.

We examined each subspecialty to identify subspecialties with higher levels of upward mobility, and our results demonstrate that the female representation of hand ($p = 0.02$) and sports medicine ($p = 0.01$) fellows relative to male fellows is increasing each year. This suggests that the gender distribution gap is closing within these 2 orthopaedic subspecialties. The

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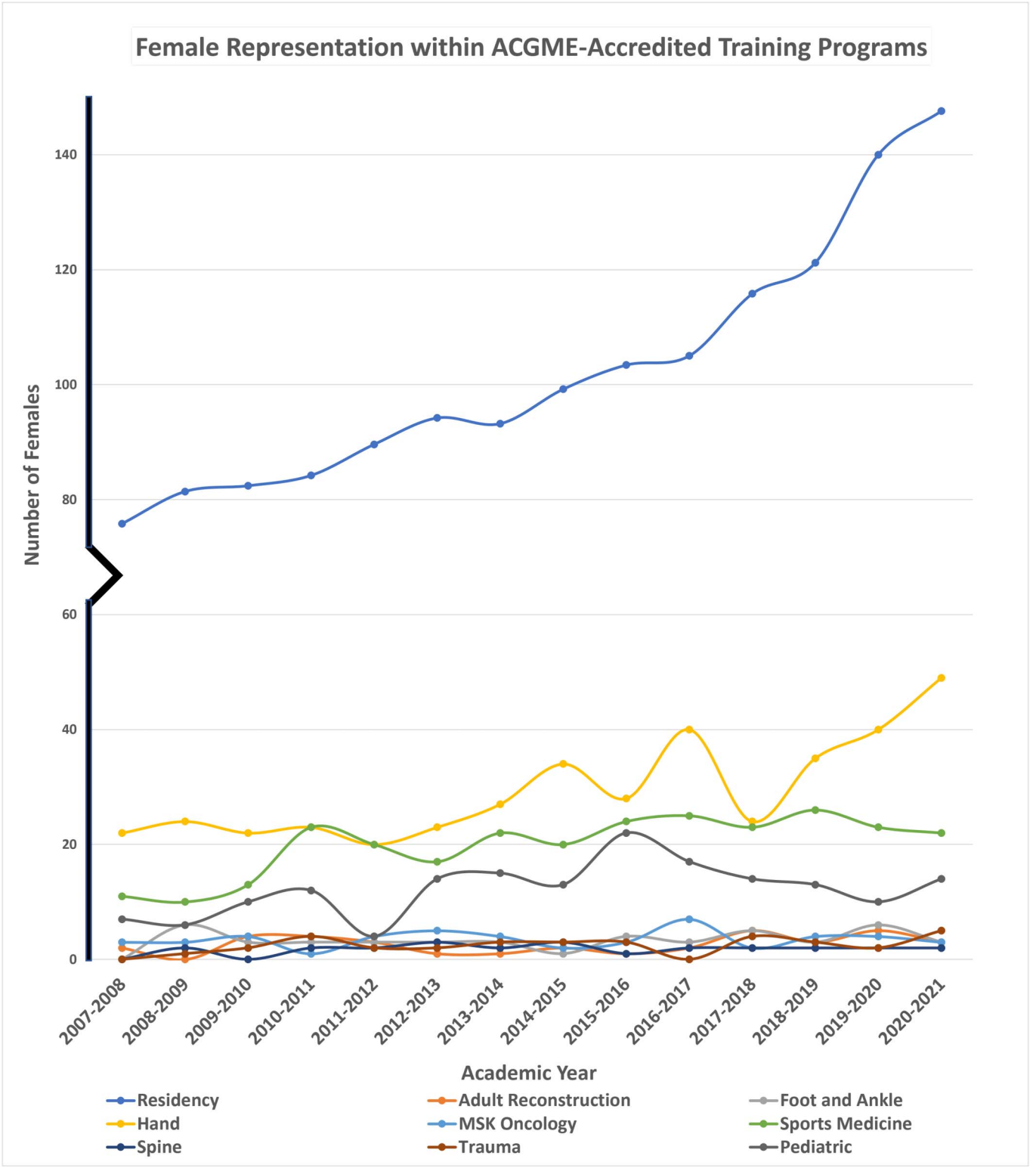

Fig. 3

The number of females within ACGME-accredited orthopaedic surgery residency and fellowship programs from 2007 to 2021. ACGME = Accreditation Council for Graduate Medical Education.

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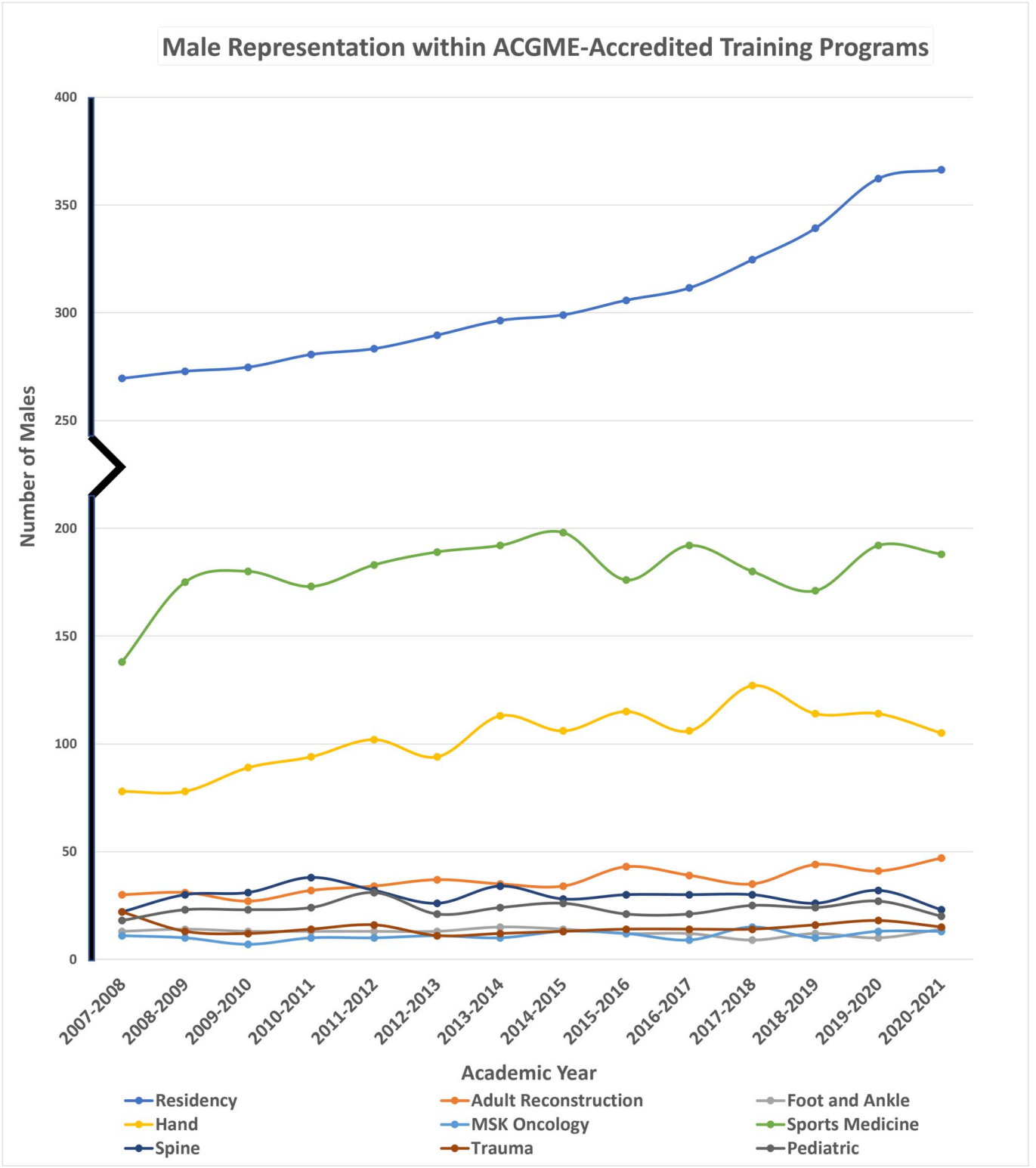

Fig. 4

The number of males within ACGME-accredited orthopaedic surgery residency and fellowship programs from 2007 to 2021. ACGME = Accreditation Council for Graduate Medical Education.

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TABLE I The Association Between Gender and Year Within General Orthopaedic Residency and Subspecialty Fellowships From 2007 to 2021

Specialty	Pearson χ^2	p Value	n
Orthopaedic residency	64.2	<0.001	49,921
Adult reconstruction	12.6	0.5	545
Foot and ankle	11.6	0.6	223
Hand	20.7	0.08	1,846
Musculoskeletal oncology	9.4	0.7	203
Pediatrics	20.9	0.07	499
Spine	6.1	0.9	437
Sports medicine	13.6	0.4	2,806
Trauma	11.6	0.6	238

Spearman correlation values for adult reconstruction, foot and ankle, musculoskeletal oncology, pediatrics, spine, and trauma were not significant, although the value for pediatrics was borderline significant (p = 0.054). This is consistent with recent literature identifying the most common subspecialties pursued by female orthopaedic surgeons as hand (24%), pediatric (19%-23%), and sports medicine (15%-16%) fellowships.[9,10]

We further analyzed the data in a logistic regression to better understand the current ratios of genders within each fellowship. Subspecialties such as pediatrics (OR = 0.3, 95% CI: 0.3-0.4), musculoskeletal oncology (OR = 0.5, 95% CI: 0.4-0.7), hand (OR = 0.6, 95% CI: 0.5-0.7), and foot and ankle (OR = 0.6, 95% CI: 0.5-0.9) saw decreased odds of male representation over time when compared with orthopaedic residency. Sports medicine (OR = 1.5, 95% CI: 1.3-1.7), adult reconstruction (OR = 2.4, 95% CI: 1.7-3.3), and spine (OR = 2.7, 95% CI: 1.8-4.1) fellowships demonstrated increased odds of male representation over time when compared with orthopaedic residency positions.

TABLE II The Correlation Between the Number of Males and Females Within General Orthopaedic Residency and Subspecialty Fellowships From 2007 to 2021

Specialty	Spearman Correlation	p Value	n
Orthopaedic residency	−0.04	<0.001	49,921
Adult reconstruction	−0.02	0.6	545
Foot and ankle	−0.08	0.2	223
Hand	−0.06	0.02	1,846
Musculoskeletal oncology	0.02	0.8	203
Pediatrics	−0.09	0.054	499
Spine	−0.05	0.3	437
Sports medicine	−0.05	0.01	2,806
Trauma	−0.09	0.1	238

TABLE III Probability of Male Representation Within Orthopaedic Subspecialty Fellowships as Compared to Residency Programs From 2007 to 2021

Specialty	Odds Ratio	95% Confidence Interval	
		Lower	Upper
Spine	2.7	1.8	4.1
Adult reconstruction	2.4	1.7	3.3
Sports medicine	1.5	1.3	1.7
Trauma	1.0	0.7	1.4
Foot and ankle	0.6	0.5	0.9
Hand	0.6	0.5	0.7
Musculoskeletal oncology	0.5	0.4	0.7
Pediatrics	0.3	0.3	0.4

Female orthopaedic surgery residents applying to fellowships in the 2010 to 2014 academic years had a significantly higher probability of matching when compared with males (96% vs 81%, p < 0.001)[11]. Although this study offers insight into the proportion of fellowship trainees within a short period, it did not analyze trends within fellowships or compare those trends with orthopaedic residency. In addition, these proportions may not fully represent the orthopaedic female residents during this time because it comprised a small subset of applicants taken from an already minority group of residents[11].

It is critical to note that not all orthopaedic fellowships are recognized by the ACGME and were therefore not included in our data set. A recent study by Silvestre et al. compared the proportion of ACGME-accredited orthopaedic surgery fellowship programs during 2013 and 2021 and found no difference between them (53% vs 48%, p = 0.17, respectively). However, a significant reduction in ACGME-accredited positions was noted when comparing 2013 and 2021 (58% vs 50%, p < 0.001, respectively), which the authors attributed to a significant reduction in pediatrics training positions (59% vs 37%, p = 0.01)[12]. Similarly, we found the pediatric subspecialty to have the significantly lowest odds of male representation when compared with orthopaedic surgery residency programs (OR = 0.3, 95% CI: 0.3-0.4). Certain specialties, such as hand, require graduation from ACGME-accredited fellowships to qualify for subspecialty certificates. Adult reconstruction does not have this requirement, which may explain the trend of particular specialties increasing or decreasing in ACGME accreditation.

Both sports medicine and hand fellowships have had significant increases in accredited programs during a similar timeframe as our study (93% vs 100%, p = 0.02 and 81% vs 99%, p < 0.001, respectively)[12], indicating that both increased female representation and increasing accreditation in sports medicine and hand programs are occurring simultaneously. By contrast, the number of ACGME-accredited adult reconstruction fellowship programs significantly decreased during this

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TABLE IV Ranges of Percentages of Female Trainees in Each Specialty From 2007 to 2021

	Female Gender (%)
Orthopaedic residency	11.6-16.7
Adult reconstruction	0.0-12.5
Foot and ankle	0.0-37.5
Hand	15.6-31.6
Musculoskeletal oncology	9.1-43.8
Sports medicine	5.0-12.7
Spine	0.0-9.7
Trauma	0.0-25.0
Pediatrics	11.4-51.5

time (40% vs 24%, p = 0.04)[12], but our results showed these programs to have significantly higher odds of male representation at 138% (OR = 2.4, 95% CI [1.7-3.3]).

Finally, our analysis showed that although holding fellowship and orthopaedic surgery residency constant, the odds of being male decreased by 3% (95% CI: 0.97-0.98) for each year. The increased recruitment of female orthopaedic residents has not distributed equally among ACGME-accredited fellowships, but our data are encouraging with suggestions that gender representation is normalizing[8-10].

Bratescu et al. conducted a survey of practicing orthopaedic female surgeons, fellows, and fellowship-matched residents investigating subspecialty choice and found that strong mentorship was the most impactful extrinsic/modifiable factor that affected the decision-making process[9]. Shah et al. investigated gender diversity at varying academic levels and found that although the amount of female orthopaedic surgeons in faculty positions increased from 9% in 1997 to 18% in 2017, these opportunities were considerably more likely for a junior rather than senior position (p < 0.001)[13]. A national review of diversity among subspecialty leadership similarly found that the highest rates of male-dominated fellowship directors were seen in adult reconstruction (100%), sports medicine (99%), and spine (96%) fellowships[8]. Increasing equitable gender representation among faculty leadership is a critical step in promoting a future generation of culturally competent, diverse orthopaedic surgeons[3]. However, the medical community should not solely rely on the already underrepresented faculty members to lead these initiatives. Instead, it would be more efficient and equitable for physicians belonging to majority groups to share in the responsibilities and support colleagues of diverse backgrounds[2,3].

Comparison with other surgical subspecialties is helpful in placing these findings in the context of other literature. A study conducted by Behmer Hansen et al. found that neurosurgery fellowship choice also remains unequally distributed between genders[14]. Similarly, another study examined advanced gastrointestinal/minimally invasive surgery fellowship programs and found that women were underrepresented[15]. In otolaryngology between 2011 and 2019, one study found that women were selecting pediatric otolaryngology fellowship at higher frequencies than men, but no significant difference was seen in the other 9 studied fellowships[16]. Some studies hypothesized that significant contributing factors to these gender distributions are the underrepresentation of female program directors and faculty, sexual harassment, and interest in the discipline[14,15]. Successful recruitment and retention strategies of female trainees in these subspecialties should be further evaluated and implemented into orthopaedic subspecialties.

Intrinsic motivations of female orthopaedic surgeons for pursuing or not pursuing fellowship, including personal satisfaction and work-life balance, are other important factors to consider. Personal satisfaction and intellectual stimulation are top-ranked reasons for female orthopaedic surgeons to pursue fellowship[9]. Neurosurgery literature further reported obstacles to the retention of women within surgical training programs as intrapersonal (work-life balance and interested in discipline), interpersonal (relationship status and presence or absence of mentors), and organizational (length of training, family, and maternity leave policies)[14]. However, this investigation was not extended to neurosurgery fellowship. Additional research into how specific fellowships across surgical subspecialties support or appeal to individuals with these motivations would provide more insight into strategies for increased recruitment of gender-diverse trainees.

Strengths of this study include a well-powered, longitudinal comparison of ACGME-accredited orthopaedic residency and fellowship gender diversity data, which has been scarcely reported. These analyses contribute toward identifying disparities in gender diversity among orthopaedic surgery residents and fellows.

Our study is limited by a retrospective review of a database that is reliant on individuals' self-reporting of gender as binary, either male or female, which may not provide an option to accurately describe oneself[17]. For comparative analysis, it is implied that reasons for not self-reporting demographics would be similar across all fields analyzed. Perhaps, the largest limitation of our study is that only ACGME-accredited orthopaedic surgery and fellowship programs were analyzed. Many orthopaedic fellowships are not ACGME-accredited, and there has been a significant decrease in positions over the past decade (p < 0.001)[12]. We are thus unable to determine the destination of female graduates if they do not matriculate to an ACGME-accredited fellowship on completion of their orthopaedic residency. As a result, our analysis of this population is limited in sample size and may overstate the female representation in subspecialty fellowships. Finally, the database we used did not specify the contribution of osteopathic physicians after the ACGME/American Osteopathic Association merger under a Single Accreditation System[18].

In summary, we found that although the percentage of female orthopaedic residents in ACGME-accredited programs increased significantly from 2007 to 2021, this has not translated to ACGME-accredited fellowship positions for women. Future research optimizing methods to improve the representation of females in orthopaedic surgery should be considered[4].

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References

1. Association of American Medical Colleges. 2022 Fall Applicant, Matriculant, and Enrollment Data Tables. 2022. https://www.aamc.org/media/64176/download?attachment. Accessed 2023.

2. Chambers CC, Ihnow SB, Monroe EJ, Suleiman LI. Women in orthopaedic surgery: population trends in trainees and practicing surgeons. J Bone Joint Surg Am. 2018;100(17):e116.

3. Haffner MR, Van BW, Wick JB, Le HV. What is the trend in representation of women and under-represented minorities in orthopaedic surgery residency? Clin Orthop Relat Res. 2021;479(12):2610-7.

4. Onuoha AC, Meadows AM, Faraj MT, Skinner MM, Day C, Ravi K. Comparative analysis of racial and gender diversity in orthopedic surgery applicants and residents from 2007 and 2019. J Orthop Exper Innov. 2022:31412.

5. Dib AG, Lowenstein NA, LaPorte DM, Samora JB, Matzkin EG. The pioneering women of orthopaedic surgery: a historical review. J Bone Joint Surg Am. 2022;104(15):e66.

6. ACGME Data Resource Book. Available at: https://www.acgme.org/about/publications-and-resources/graduate-medical-education-data-resource-book/. Accessed June 5, 2023.

7. Meadows AM, Skinner MM, Faraj MT, Hazime AA, Day RG, Fore JA, Day CS. Racial, ethnic, and gender diversity in academic orthopaedic surgery leadership. J Bone Joint Surg Am. 2022;104(13):1157-65.

8. Kamalapathy PN, Raso J, Rahman R, Harihar S, Lozano-Calderon S, Hassanzadeh H. Orthopedic surgery fellowship directors: trends in demographics, education, employment, and institutional familiarity. HSS J. 2023;19(1):113-9.

9. Bratescu RA, Gardner SS, Jones JM, Siff TE, Lambert BS, Harris JD, Liberman SR. Which subspecialties do female orthopaedic surgeons choose and why? Identifying the role of mentorship and additional factors in subspecialty choice. J Am Acad Orthop Surg Glob Res Rev. 2020;4(1):e19.00140.

10. Rohde RS, Wolf JM, Adams JE. Where are the women in orthopaedic surgery? Clin Orthop Relat Res. 2016;474(9):1950-6.

11. Cannada LK. Women in orthopaedic fellowships: what is their match rate, and what specialties do they choose? Clin Orthop Relat Res. 2016;474(9):1957-61.

12. Tippabhatla A, Silvestre J, Torres-Izquierdo B, Garvin L II, Shea KG, Kelly JD IV, Hosseinzadeh P. Understanding financial relationships between orthopedic surgeons and industry for research. Orthopedics. 2023:1-7.

13. Shah KN, Ruddell JH, Scott B, Reid DB, Sobel AD, Katarincic JA, Akelman E. Orthopaedic surgery faculty: an evaluation of gender and racial diversity compared with other specialties. JBJS Open Access. 2020;5(3):e20.00009.

14. Behmer Hansen RT, Silva NA, Cuevas R, Cerasiello SY, Richardson AM, Mammis A, Nanda A. Fellowship, gender, and scholarly productivity: trends among academic neurosurgeons in the US. J Neurosurg. 2020;135(1):185-93.

15. Wolbrom DH, Brunt LM, Lidor A, Jeyarajah DR, Mattar SG, Pryor A. Gender disparities in gastrointestinal surgery fellowship programs. Surg Endosc. 2022;36(6):3805-10.

16. Miller RH, McCrary HC, Gurgel RK. Assessing trends in fellowship training among otolaryngology residents: a national survey study. Otolaryngol Head Neck Surg. 2021;165(5):655-61.

17. Connor J, Madhavan S, Mokashi M, Amanuel H, Johnson NR, Pace LE, Bartz D. Health risks and outcomes that disproportionately affect women during the Covid-19 pandemic: a review. Soc Sci Med. 2020;266:113364.

18. Cummings M. The impact of the ACGME/AOA Single accreditation System on osteopathic surgical specialties, residents, and DO students. J Surg Educ. 2021;78(5):1469-75.