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AOA Critical Issues in Education

A 15-Year Report on the Uneven Distribution of Women in Orthopaedic Surgery Residency Training Programs in the United States

Ann E. Van Heest, MD, Julie Agel, MA, and Julie Balch Samora, MD, PhD

Investigation performed at Nationwide Children's Hospital, Columbus, OH

Background: This study was undertaken to update reports from 2004 to 2005 through 2008 to 2009, and 2009 to 2010 through 2013 to 2014, including 5 additional years of GME Track data. Our hypothesis is there have been no significant changes during the past 5 years in the distribution of Accreditation Council for Graduate Medical Education (ACGME)-accredited orthopaedics residency programs that train female residents, compared with the previous 10 years.
Methods: Data for ACGME-accredited orthopaedics residency training programs in the United States were analyzed for 5 consecutive academic years (2014-2015 through 2018-2019). Programs were classified as having no women, 1 woman, 2 women, or greater than 2 women in training. Programs were analyzed for percentage of female residents and classified as having above the national average (>20%), similar to the national average (between 10 and 20%), or below the national average (<10%).
Results: Analysis of the original 5 years (2004-2009) compared with the most recent data (2014-2019) demonstrated a statistically significant improvement in the number of programs training women ($p < 0.001$). From 2004 to 2009 to 2014 to 2019, the absolute number and percent of female trainees have increased ($p < 0.001$). Similar analysis of the middle 5 years (2009-2014) compared with the most recent 5 years (2014-2019) did not demonstrate a statistically significant change ($p = 0.12$). From 2014 to 2019, residency programs in the United States continue to train women at unequal rates: 37 programs had no female trainees, while 53 programs had >20% female trainees during at least one of these 5 years.
Conclusions: Female medical students continue to pursue orthopaedics at rates lagging behind all other surgical specialties. Not all residency programs train women at equal rates. If the rate of training of female residents over the past 15 years were projected over time, we would not achieve 30% women within orthopaedics residency training programs until approximately 2060.
Level of Evidence: III.

Although 57% of undergraduates are female and 50% of medical students are female, only 15% of orthopaedic residents are female (Fig. 1). Over the past 15 years, there has been a slow, yet steady, increase in the percent of women choosing orthopaedic surgery training (Fig. 2). Brotherton et al. published annual Graduate Medical Education

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSOA/A276).

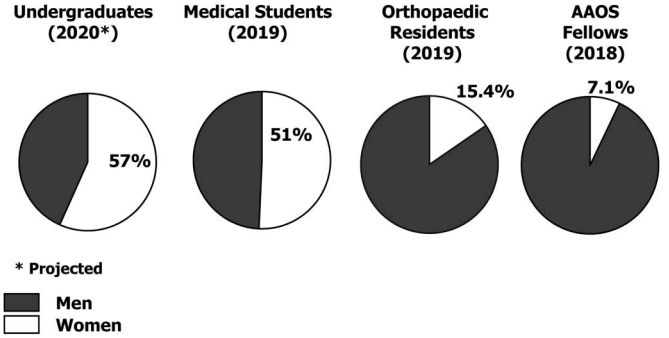

Fig. 1

Sex profile according to the level of education. AAOS= American Academy of Orthopaedic Surgeons.

(GME) demographics of all residency training programs in the United States[1-6]. In a recent report (Table I), the percent of female residents showed a wide variability in the top 10 specialties by size (83% ob/gyn to 14% orthopaedic surgery). Orthopaedic surgery has a smaller percentage of female trainees compared with all other surgical specialties (Fig. 3).

"*The Uneven Distribution of Women in Orthopaedic Surgery Residency Training Programs in the United States*" examined GME Track data for 5 academic years from 2004 to 2005 through 2008 to 2009[8]. Orthopaedic residency programs across the United States do not train women at an equal frequency. In that report, more than one-third of orthopaedic residency programs in the United States trained very few women, that is, had an average of <10% female trainees over the 5-year period. However, more than ten programs had an average of >20% female trainees over the 5 years.

"*A 5-Year Update on the Uneven Distribution of Women in Orthopaedic Surgery Residency Training Programs in the United States*"[9] updates the report to include data from 2009 to 2010 through 2013 to 2014. From 2004 to 2009, the mean percentage of female trainees in US orthopaedic surgery residency programs was 11.6%, and from 2009 to 2014, this mean percentage increased to 13.6%. Residency programs continued to train women at unequal rates. Thirty programs had no female trainees during at least one of the 5 years, and 8 programs had no female trainees during each of the 5 years. On the other end of the spectrum, 49 programs had >20% female residents enrolled during one of the 5 years and 9 programs had >20% female residents during all 5 years.

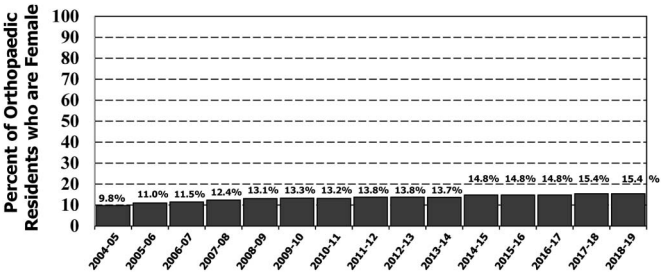

Fig. 2

Percentage of women in orthopaedic surgery residency programs in the United States according to academic year.

This study will test the hypothesis that there have been no significant changes during the past 5 years, 2014 to 2015 through 2018 to 2019, in the distribution of Accreditation Council for Graduate Medical Education (ACGME)-accredited orthopaedic surgery residency programs that train female residents, when compared with the previous 10 years.

Materials and Methods

The GME Track is a resident database and tracking system to track national census data. It is run jointly by the Association of American Medical Colleges (AAMC) and the American Medical Association (AMA). Since 2009, orthopaedic surgery is tracked for PGY1 through PGY5. Sex data are required for each resident entered in the GME Track database as a binary value: male or female.

Data for all ACGME-accredited orthopaedic surgery residency training programs were analyzed for 5 consecutive academic years (2014-2015 through 2018-2019) similarly to previous reports (2004-2005 through 2008-2009, and 2009-2010 through 2013-2014)[8,9]. One program was excluded because it had fewer than 2 residents per training year.

The number and percentage of female residents in training at each institution during each academic year were recorded. Programs were classified as having no women, 1 woman, 2 women, or greater than 2 women in training for each of the 5 academic years. Programs were also analyzed for percentage of female residents in training and classified as having above the national average (>20%), similar to the national average (between 10 and 20%), or below the national average (<10%) for the 5 academic years. For programs with no women in training, they were further classified as to how many of the 5 academic years they had no women. The number of women and male residents in training for each of the past 15 years was reported.

Descriptive statistics were used to calculate frequency counts, percentages, and χ^2 analysis. Excel and SPSS, v.26 were used for all analysis.

Source of Funding

This project was supported by an AAOS grant through the Diversity Advisory Board. The grant was used to purchase GME Track data from AAMC for orthopaedic surgery resident data by residency program, specialty, and sex for academic years 2014 to 2015 through 2018 to 2019. The views expressed herein are those of the authors and do not necessarily reflect the position or policy of the AAMC.

Results

Averaged over 5-year periods, the percent of female trainees in orthopaedic surgery residency programs has increased from an average of 11.6% female resident trainees in 2004 to 2009, and an average of 13.6% female trainees in 2009 to 2014, to an average of 15.0% female trainees in 2014 to 2019. The number of women and male residents for each of the past 15 years is shown in Table II. A comparison of the proportion of residents who were women in 2004 to 2005 compared with the proportion of

TABLE I 2019 Top 10 Specialties by Size

Specialty	No. of Residency Positions	Percent of All Residency Positions	No. of Female Residents	Percent of Female Residents
Internal medicine	27,179	20	11,474	42
Family medicine	12,441	9	6,670	54
General surgery	9,303	7	3,839	41
Pediatrics	8,950	7	6,449	72
Emergency medicine	7,681	6	2,722	35
Anesthesiology	6,141	5	2,065	34
Psychiatry	6,014	4	2,999	50
Obstetrics/gynecology	5,453	4	4,550	83
Radiology	4,362	3	1,171	27
Orthopaedic surgery	4,021	3	619	15

Source: Brotherton and Etzel, Graduate Medical Education, 2018-2019. JAMA. 2019;322:996-1016.[7]

residents who were women in 2018 to 2019 shows a statistically significant increase ($p < 0.001$).

Variations in Residency Program Female Demographics

Residency programs in the United States do not train women at an equal rate. The number of women enrolled in orthopaedic surgery residency programs during each academic year between 2014 and 2019 is shown in Fig. 4. From 2014 to 2019, the number of programs that were training no women decreased: 25 of 175 orthopaedic residency programs had no women enrolled (PGY1-5) during the 2014 to 2015 academic year; 23 of 177 had no women in 2015 to 16; 19 of 178 had no women in 2016 to 17; 12 of 176 had no women in 2017 to 18; and 12 of 179 had no women in 2018 to 2019. The number of residency programs that enrolled only one woman was 36 in 2014 to 2015, 31 in 2015 to 2016, 34 in 2016 to 2017, 29 in 2017 to 2018, and 33 in 2018 to 2019.

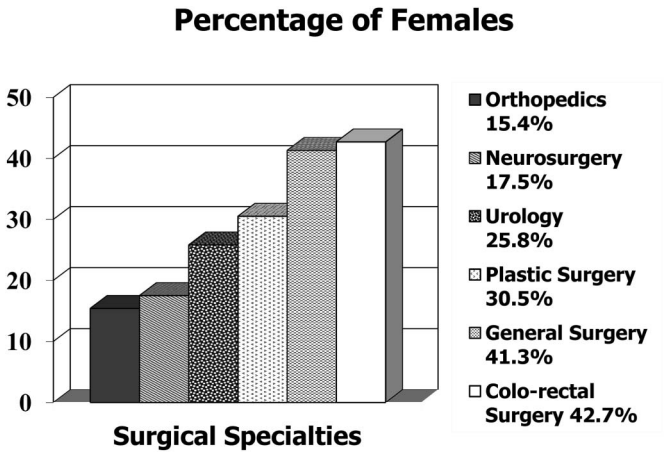

Fig. 3

Percentage of women in surgical residency programs in the United States in 2014 according to surgical specialty. Source: Brotherton SE, Etzel SI. Graduate Medical Education, 2018-2019. JAMA. 2019;322:996-1016.[7]

The percentage of women during each academic year between 2014 and 2019 is shown in Fig. 5. Over the most recent 5 years of GME Track data, between 175 and 179 programs met inclusion criteria for analysis. For these 5 years, between 45% and 53% of residency programs in the United States trained very few women, that is, had an average of <10% female trainees over the 5-year period. Between 27% and 44% of residency programs in the United States trained more than an average amount of women, that is, had an average of >20% female trainees over the 5 years.

2014 to 2019 Data Compared with 2004 to 2009 and with 2009 to 2014 Data

χ^2 analysis of the original 5 years of GME Track data (2004-2009) examining PGY2-5, compared with the most recent 5 years of GME Track data (2014-2019) examining PGY1-5, demonstrated a statistically significant improvement in the number of programs training women ($p < 0.001$). From 2004 to 2009, 39% of programs were training 0 to 1 women, which decreased to 29% of programs from 2014 to 2019. From 2004 to 2009, 61% of programs were training ≥ 2 women, which increased to 71% from 2014 to 2019. Similar analysis of the middle 5 years of GME Track data (2009-2014) compared with the most recent 5 years of data (2014-2019) did not demonstrate a statistically significant change ($p = 0.12$). Programs training 0 to 1 women remained minimally changed (32% vs. 29%). Programs training ≥ 2 women were minimally changed as well (68% vs. 71%).

Discussion

This study tested the hypothesis that there have been no significant changes during the past 5 years (2014-2019) in the distribution of ACGME-accredited orthopaedic surgery residency programs that train female residents, when compared with the previous 10 years. Significant positive improvements are seen when the 2014 to 2019 data are compared with the earliest (2004-2009) data: The number and the percentage of female trainees have increased, and the number of residency programs training few women has decreased while

TABLE II Number of Male and Female Residents in Training by Year

Year	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
No. of Women	297	347	352	378	417	488	502	520	537	547	528	548	563	603	610
No. of Men	2,670	2,784	2,731	2,686	2,760	3,162	3,247	3,313	3,344	3,426	3,176	3,238	3,309	3,352	3,353
Total Number	2,967	3,131	3,083	3,064	3,177	3,650	3,749	3,833	3,881	3,973	3,704	3,786	3,872	3,955	3,963

the number of residency programs training >20% women has increased. However, when the 2014 to 2019 data are compared with the 2009 to 2014 data, although continued positive trends exist, statistically significant improvements are not present, indicating that the rate of change is very slow for increasing sex diversity in orthopaedic surgery residency training. About one-third of programs still train 0 to 1 women. If one subscribes to the diversity goal of 30% within a group[10], projecting the training rate of female residents using the past 15 years of data (assuming the number of programs and residents remains constant), the goal of 30% women within orthopaedic surgery residency training programs would not be achieved until 2060.

Diversity enhances both education and patient care by advancing cultural competency, promoting an inclusive environment, improving access to care, and leading to better outcomes. Research has shown that patients often prefer treatment by physicians of the same sex[11]. In a large Commonwealth Fund study representing 87 million men and 104 million women aged 18 years and older in the United States, women seek more medical care than men along the age spectrum[12]. Furthermore, women have been shown to have higher rates of orthopaedic surgical interventions than men[13]. With many female orthopaedic patients, diversifying the workforce of orthopaedic surgeons provides patients with greater choice. Bennett et al.[14] found that it will take orthopaedic surgery 138 years to reach levels of female representation comparable with that of the overall US population.

The reasons for this disparity are not entirely clear but are likely multifactorial. It does not seem that academic metrics explain the underrepresentation of women in orthopaedic residencies[15]. Rao et al.[16] found that medical students pursued their specialty on lifestyle/quality of life issues as well as the subject matter itself. In a survey distributed to members of the Ruth Jackson Orthopaedic Society, the most common reasons cited for why women might not choose orthopaedic surgery were perceived inability to have good work/life balance, perception that too much physical strength is required, and lack of strong mentorship[17]. It has been suggested that orthopaedics as a specialty has inherent barriers, including a culture of long hours, personal sacrifice, a lack of flexibility, and a heavy workload[18].

Perhaps, orthopaedics is perceived as a specialty unwelcome to women. Samora et al.[19] found that 81% of female respondents of an AAOS survey had experienced discrimination, bullying, or harassment. Similarly, in a Ruth Jackson Orthopaedic Society survey, 68% of women reported having experienced sexual harassment during their orthopaedic training,

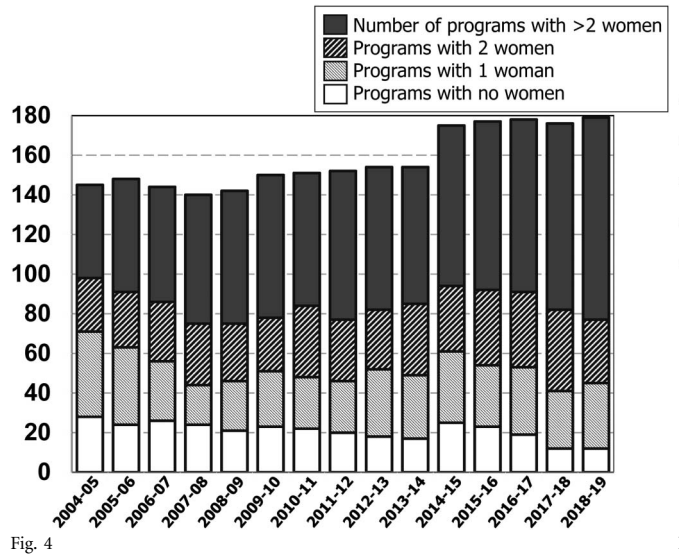

Fig. 4

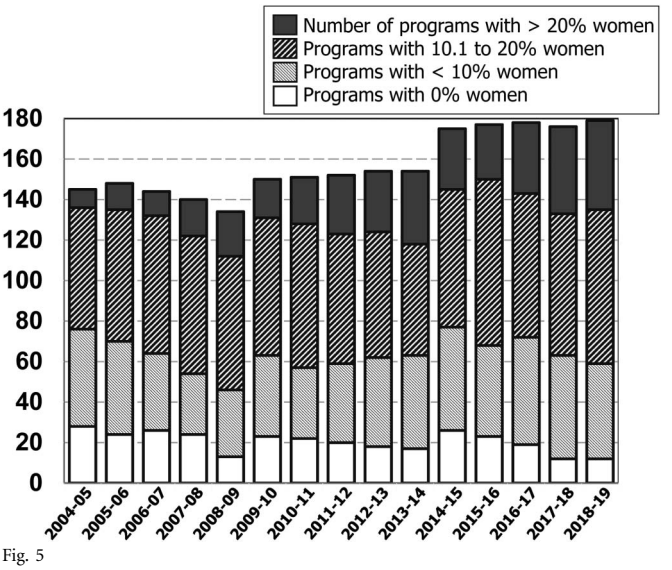

Fig. 5

Fig. 4 Graduate Medical Education Track data for the number of women in orthopaedic surgery residency programs in the United States according to academic year. **Fig. 5** Graduate Medical Education Track data for the percentage of women in orthopaedic surgery residency programs in the United States according to academic year.

and 61.7% reported being asked an inappropriate question during residency interviews, including issues about child-bearing and marital status[20,21]. In a survey of women in orthopaedics, 74% had experienced microaggressions, which are defined as verbal, nonverbal, or environmental slights that are either intentional or unintentional conveying hostile, derogatory, or otherwise negative messages[22].

Perhaps decisions about family planning and pregnancy may affect career choice. There is significant variability in residency programs with maternity leave policies[23]. In a survey distributed to members of the American Orthopaedic Association's Council of Orthopaedic Residency Directors, 53% of male program directors believed that pregnancy and parenthood negatively affected female residents' scholarly activities[24]. Furthermore, they believed that pregnancy and parenthood imposed a burden on fellow trainees.

Lack of exposure early in training to the musculoskeletal system is another potential factor. Medical school experiences have been shown to shape female students' interest in orthopaedic surgery[25]. As much as 75% of female orthopaedic surgeons reported lesser degrees of exposure to orthopaedic surgery than to other surgical subspecialities[26]. Mandatory musculoskeletal instruction during medical school was associated with a 12% increase in application to orthopaedics[27].

The presence of female residents was ranked in the top 5 most important factors for female applicants[28]. Women place more importance on the presence of female and racial/ethnic minority faculty. Female representation in orthopaedic faculty has increased in the past 15 years (Table III). Okike et al.[29] also demonstrated that underrepresented minorities (URM) who attended medical school at institutions with high URM representation on orthopaedic faculty and in residencies were more likely to apply to orthopaedics. Geographical differences exist, with the Mid-Atlantic region having the lowest percentage of female orthopaedic faculty (5.6%) compared with the mountain region (18%)[30]. The lowest female representation in residencies is in the South, with the highest in the Northeast and West[31].

Objective measures of career productivity, leadership positions, and academic success have been shown to be inferior for women than for men, which could be a factor in career choice. Women average fewer publications than their male counterparts in orthopaedic sports medicine and are more frequently attributed middle authorship rather than senior authorship[32]. From 1987 to 2017, 1.7% of senior authors and 4.4% of first authors of orthopaedic publications were female[33]. There has never been a female editor-in-chief of the 3 major orthopaedic journals[34]. The majority of women have academic rank of instructor, with only 8.7% achieving full professor[35]. Only 1 woman (1%) was department chair during the 2015 to 2016 academic year[35]. There are also income disparities, with female orthopaedic surgeons earning $62,000 less income per year compared with men, accounting for subspecialty choice, hours worked, work status, case volume, years in practice, and practice setting[36]. Possible explanations for this difference may include fewer women in private practice and women holding positions of lesser rank in academia. Men also receive 3 times more industry payments than women in orthopaedics[37].

Challenging this disparity will require a multifaceted strategy that includes increasing exposure at all levels to foster the pipeline and maintain the women in this field. Leadership is critical to promote a culture of diversity and inclusion. Leaders must provide mentorship, opportunities, and resources for women/URM to be successful as they advance through their careers and must consider inclusion criteria for diverse candidates[10]. In the National Football League, the "Rooney Rule" was adopted in 2003 requiring teams to interview at least one minority candidate when choosing a new head coach, which increased the number of minority coaches in the league.

As size of the minority group increases, there will be continued benefits for the successes of future minorities in the

TABLE III Distribution of US Medical School Orthopaedic Faculty by Sex and Rank 2019, 2014, and 2009

2019	Professor	Associate Professor	Assistant Professor	Instructor
Female	96	135	424	131
Total	892	911	1901	317
Percent	10.8	14.8	22.3	41.3
2014	**Professor**	**Associate Professor**	**Assistant Professor**	**Instructor**
Female	49	94	255	71
Total	738	705	1,369	267
Percent	6.6	13.3	18.6	26.6
2009	**Professor**	**Associate Professor**	**Assistant Professor**	**Instructor**
Female	29	76	183	54
Total	600	607	1,160	236
Percent	4.8	12.5	15.8	22.9

field; as the minority group approaches 30%, the larger representation makes the group no longer a minority. Having a role model of the same sex is significantly more important for women in influencing their decision to pursue orthopaedics[38]. Furthermore, same sex mentorship has been associated with career choice, academic success, and high job satisfaction[39]. Programs with more female faculty members and more women in leadership positions tend to have more female residents[40]. Similarly, women who attended medical schools with high faculty sex diversity and high resident sex diversity were more likely to apply for orthopaedics[41]. There is a strong correlation between the percentage of women in an orthopaedic subspecialty society and the percentage of women on the society's board of directors[42]. Representation of female speakers at annual meetings has been shown to be largely proportionate to the membership of women in societies[43]. Increased numbers of women in leadership and as speakers in societies with greater female representation may be a chicken and egg paradox, that is, which existed first and which caused the other.

Diversity of applicants should be pursued and measured. Pipeline programs and early exposure can have a positive impact on pursuit of an orthopaedic career[44,45]. We should be cognizant to dispel negative misconceptions and support a culture without biases that will encourage individuals from all backgrounds to consider a career in orthopaedics. With diversity as a priority, we can create and maintain a workforce that better reflects the US population to reduce healthcare disparities, improve the overall health of our population, and enrich the field of orthopaedics.

There were several weaknesses to this study. The findings of this study were based on GME Track data, a national database of information required by the AMA and the AAMC. If the data entered into this database were inaccurate or incomplete, the results presented in this study would also be inaccurate or incomplete. Despite these limitations, these data were the most accurate sex data available for residency training programs in the United States, as they are required by the AMA and AAMC. The GME Track data did not include important information that would be helpful in understanding why women are poorly represented in orthopaedic surgery residency programs (i.e., data regarding application and match rates for female and male medical students, the quality and background of medical student applicants, or the scholastic performance of male and female residents).

In conclusion, the findings of this study confirm that ACGME orthopaedic residency programs continue to train fewer women than other specialties, with minimal change over the past 15 years. Providing a greater exposure to orthopaedics during medical school, increasing the number of female faculty to serve as role models, and creating an environment of acceptance led by senior surgical faculty are recommended steps toward increasing sex diversity in orthopaedic residency programs. ■

Ann E. Van Heest, MD[1]
Julie Agel, MA[1]
Julie Balch Samora, MD, PhD[2]

[1]University of Minnesota, Department of Orthopaedic Surgery, Minneapolis, Minnesota

[2]Nationwide Children's Hospital, Columbus, Ohio

E-mail address for J.B. Samora: julie.samora@nationwidechildrens.org

ORCID iD for A.E. Van Heest: 0000-0002-8064-5508
ORCID iD for J. Agel: 0000-0002-4296-7389
ORCID iD for J.B. Samora: 0000-0002-3700-7471

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