

TOPICS IN TRAINING

A 5-Year Update on the Uneven Distribution of Women in Orthopaedic Surgery Residency Training Programs in the United States

Ann E. Van Heest, MD, Felicity Fishman, MD, and Julie Agel, MA

Investigation performed at the Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, Minnesota

Background: This study was undertaken to update our report from academic years 2004-2005 through 2008-2009, to include 5 additional years of the Association of American Medical Colleges GME Track data. This study will test the hypothesis that, when compared with the data from 2004-2005 through 2008-2009, there were no substantial changes from 2009-2010 through 2013-2014 in the distribution of orthopaedic surgery residency programs that train female residents and have been accredited by the Accreditation Council for Graduate Medical Education (ACGME).

Methods: Data for all ACGME-accredited orthopaedic surgery residency training programs in the United States were analyzed for 2009-2010 through 2013-2014, in the same manner as our previous report analyzed data for 2004-2005 through 2008-2009. Programs were classified as having 0, 1, 2, or >2 women in training (i.e., for postgraduate year [PGY]-1 through PGY-5) for each of the 5 academic years. Programs were also analyzed for the percentage of female residents in training and were classified as being above the national average (>20%), similar to the national average (between 10% and 20%), or below the national average (<10%) for each of the 5 academic years.

Results: During the time period of 2004 to 2009, the mean percentage of female trainees in U.S. orthopaedic surgery residency programs was 11.6%, and during the time period of 2009 to 2014, this mean percentage increased to 12.6%. Residency programs in the United States do not train women at an equal rate. In the 5 years examined (2009 to 2014), 30 programs had no female trainees and 49 programs had >20% women enrolled in at least 1 of the 5 years, 8 programs had no female trainees enrolled in any of the 5 years, and 9 programs had >20% women enrolled in each of the 5 years.

Conclusions: Female medical students continue to pursue orthopaedic surgery as a career at rates lagging behind all other surgical specialties. Not all residency programs train women at equal rates. The period of 2009-2010 through 2013-2014 showed a greater percentage of programs (68%) training ≥ 2 women than the period of 2004-2005 through 2008-2009 (61%). Obstacles to attracting women to orthopaedic surgery should continue to be identified and to be addressed.

Peer Review: This article was reviewed by the Editor-in-Chief and one Deputy Editor, and it underwent blinded review by two or more outside experts. The Deputy Editor reviewed each revision of the article, and it underwent a final review by the Editor-in-Chief prior to publication. Final corrections and clarifications occurred during one or more exchanges between the author(s) and copyeditors.

Disclosure: One author of this study (A.E.V.H.) received a grant from the Association of American Medical Colleges. Funds were used to pay for GME Track data. The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article.

Although recent data have shown that 58% of undergraduates and 47% of medical students are female, only 14% of orthopaedic residents are female (Fig. 1). From 2004 to 2014, there was no substantial change in the percentage of women choosing orthopaedic surgery training (Fig. 2). Brotherton and Etzel have published annual graduate medical education (GME) demographic characteristics of all residency training programs in the United States¹⁻⁶. In their 2013 to 2014 report (Table I), the percentage of female residents by specialty showed a wide range from obstetrics and gynecology with the highest percentage (83%) to orthopaedic surgery with the lowest percentage (14%). In fact, orthopaedic surgery has a smaller percentage of female trainees compared with all other surgical specialties (Fig. 3).

One of the Accreditation Council for Graduate Medical Education (ACGME) program requirements for orthopaedic surgery training programs states⁷: "It is strongly suggested that the program policies for resident selection recognize the value and importance of recruiting qualified women and minority students." As a profession, we cannot state that we recruit and accept the best and the brightest medical students to learn, graduate, and practice orthopaedics as a career if we continue to fail to attract and to accept more women into our ranks. Adding diversity to an organization has shown to provide more perspectives for effective decision-making, more innovation and creativity for organizations, and greater understanding of the patient population that we treat⁸. Diversity expands the talent pool and strengthens organizations⁹.

In an earlier study, we examined GME Track data for 5 academic years from 2004-2005 through 2008-2009¹⁰. We found that orthopaedic residency programs across the United States do not train women at an equal frequency. In that report, >50 orthopaedic residency programs in the United States trained very few women (i.e., had a mean of <10% female trainees over the 5-year period). Additionally, >10 programs trained more than an average proportion of women (i.e., had a mean of >20% female trainees over the 5-year period). The current study was undertaken to update our earlier report to include 5 additional years of GME Track data. The current study tested the hypothesis that, when compared with the period of 2004-2005 through 2008-

2009, there were no changes in the time period of 2009-2010 through 2013-2014 in the distribution of ACGME-accredited orthopaedic surgery residency programs that train female residents.

Materials and Methods

The GME Track is a resident database and tracking system introduced in March 2000 to track national GME census data. It is run jointly by the Association of American Medical Colleges (AAMC) and the American Medical Association (AMA). Prior to 2009, orthopaedic surgery was tracked for postgraduate year (PGY)-2 through PGY-5. In the present report, orthopaedic surgery was tracked for PGY-1 through PGY-5; thus, the total number of residents trained is larger in the present study than it was in the previous study. Sex data are required for each resident entered in the GME Track database.

Data for all ACGME-accredited orthopaedic surgery residency training programs in the United States were analyzed for 5 consecutive academic years (2009-2010 through 2013-2014) in the same manner as in our previous report of 5 consecutive academic years (2004-2005 through 2008-2009). Programs with fewer than 2 residents per year of training were excluded because the percentage of women in small programs would skew statistical analysis of the percentage of women trained; one program was thus excluded.

The number and percentage of female residents in training at each institution during each academic year was recorded. Programs were classified as having 0, 1, 2, or >2 women in training (i.e., for PGY-1 through PGY-5) for each of the 5 academic years. Programs were also analyzed for the percentage of residents in training who were women and were classified as being above the national average (>20%), similar to the national average (between 10% and 20%), or below the national average (<10%) for each of the 5 academic years.

Descriptive statistics were used to calculate frequency counts, percentages, and the chi-square statistic. Excel (Microsoft) and SPSS version 21 (IBM) were used for all analysis. Significance was set at $p < 0.05$.

For programs with no women in training (PGY-1 through PGY-5), the programs were further classified according to the number of academic years of the 5 years during which they had no women. All programs with no women in training for 1 to 5 years were then contacted by e-mail and telephone; if no reply was obtained, the web site for the program was evaluated, looking for the accuracy of the GME Track data. Programs with no women in their program were also asked if female medical students had rotated in the program, whether women had been ranked in the match by the program, and if there were perceived obstacles to matching women in the program. Programs with >20% female residents for at least 1 year or all 5 years (2009 to 2014) were also contacted via e-mail. If no reply was obtained, the web site for the program was evaluated in an attempt to confirm the accuracy of the GME Track data. These programs were additionally asked what factors may have

Background

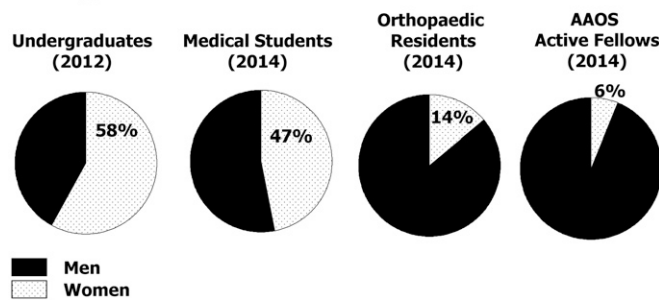


Fig. 1

Fig. 1 Sex profile according to the level of education. AAOS = American Academy of Orthopaedic Surgeons. **Fig. 2** Percentage of women in orthopaedic surgery residency programs in the United States according to academic year.

% Women in Orthopedic Surgery

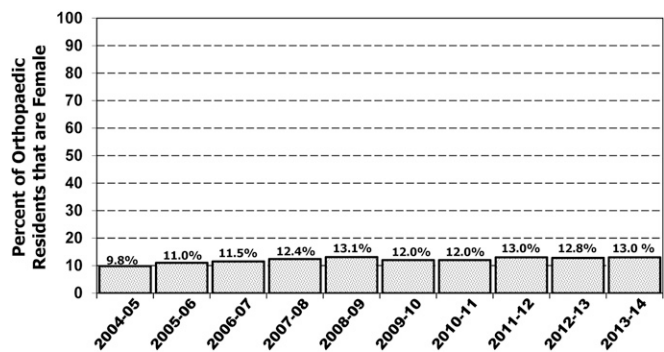


Fig. 2

TABLE 1 Top 10 Specialties by Size in 2013 to 2014*

Specialty	No. of Residency Positions	Percentage of All Residency Positions	No. of Female Residents	Percentage of Female Residents
Internal medicine	22,971	20%	9,984	44%
Family medicine	10,077	9%	5,558	55%
Pediatrics	8,529	7%	6,233	73%
Surgery, general	7,890	7%	2,962	38%
Anesthesiology	5,668	5%	2,040	36%
Emergency medicine	5,631	5%	2,107	37%
Obstetrics and gynecology	4,942	4%	4,079	83%
Psychiatry	4,917	4%	2,666	54%
Radiology	4,471	4%	1,218	27%
Orthopaedic surgery	3,529	3%	483	14%

*Data in this table were obtained from: Brotherton SE, Etzel SI. Graduate medical education, 2013-2014. JAMA. 2014 Dec 10;312(22):2427-45.

contributed to their ability to match women into their training program, if there were female attending physicians holding formal leadership positions within the program, and if there were any perceived obstacles to matching women into the program.

Results

During the time period of 2004 to 2009, the mean percentage of female trainees in U.S. orthopaedic surgery residency programs was 11.6%, and during the time period of 2009 to 2014, this mean percentage increased to 12.6%.

Number of Women in Orthopaedic Surgery Residency Programs

Orthopaedic residency programs that had no women (PGY-1 to PGY-5) enrolled totaled 23 of 150 programs during the 2009-2010 academic year, 22 of 151 programs in 2010 to 2011,

20 of 152 programs in 2011 to 2012, 18 of 154 programs in 2012 to 2013, and 17 of 154 programs in 2013 to 2014 (Fig. 4). The number of residency programs that enrolled only 1 woman was 28 in 2009 to 2010, 26 in 2010 to 2011, 26 in 2011 to 2012, 34 in 2012 to 2013, and 32 in 2013 to 2014.

Percentage of Women in Orthopaedic Surgery Residency Programs

To take into account size variations among the orthopaedic residency programs, the percentage of female trainees in each program was calculated. For the new GME Track data examined for 2009-2014, between 150 and 154 programs met inclusion criteria for analysis. For these 5 years, approximately 40% of programs in the United States trained very few women (i.e., had an average of $\leq 10\%$ female trainees over the 5-year period)

Percentage of Females

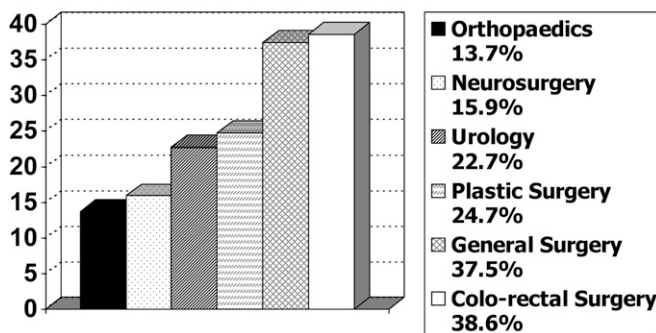


Fig. 3

Fig. 3 Percentage of women in surgical residency programs in the United States in 2014 according to surgical specialty. Data in this figure were obtained from: Brotherton SE, Etzel SI. Graduate medical education, 2013-2014. JAMA. 2014 Dec 10;312(22):2427-45. **Fig. 4** GME Track data for the number of orthopaedic surgery residency programs in the United States, according to academic year, with 0, 1, 2, or >2 women enrolled.

GME Track Data

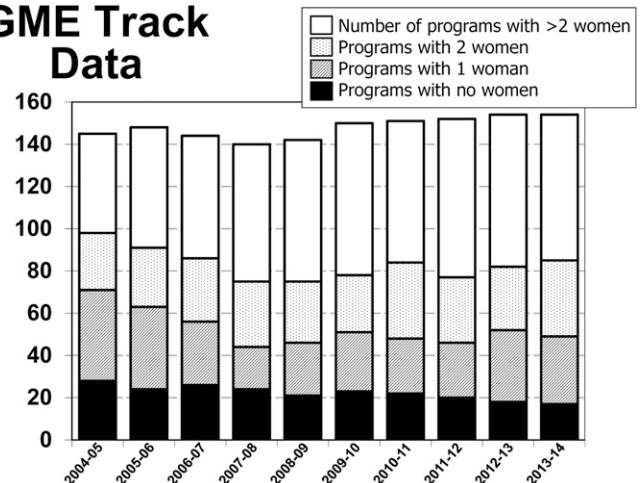


Fig. 4

TABLE II Orthopaedic Residency Program Sex Profile as Recorded on GME Track Data Reporting No Female Residents from 2009 to 2014

Programs Reporting No Female Residents Recorded in at Least 1 Year but Not All 5 Years	Programs Reporting No Female Residents Recorded in Any Year
Albany Medical Center Program	Albert Einstein Healthcare Network Program
Allegheny General Hospital-Western Pennsylvania Hospital Medical Education Consortium (AGH)	Kingsbrook Jewish Medical Center Program
Atlanta Medical Center Program	Marshall University School of Medicine Program
Banner Good Samaritan Medical Center Program	Mount Carmel Health System Program
Cedars-Sinai Medical Center Program	St. Mary's Hospital and Medical Center Program
Detroit Medical Center Corporation Program	University of Tennessee College of Medicine at Chattanooga Program
Fort Wayne Medical Education Program	UPMC [University of Pittsburgh Medical Center] (Hamot) Program
Geisinger Health System Program	Wayne State University School of Medicine Program
Icahn School of Medicine at Mount Sinai/St. Luke's-Roosevelt Hospital Center Program	
Madigan Healthcare System Program	
McLaren-Flint Program	
Medical University of South Carolina Program	
Monmouth Medical Center Program	
New York Medical College at St. Vincent's Hospital Manhattan Program	
Texas A&M College of Medicine-Scott and White Program	
Texas Tech University (Lubbock) Program	
Tripler Army Medical Center Program	
University of California (Irvine) Program	
University of California (San Francisco)/Fresno Program	
University of Chicago Program	
University of Florida Program	
University of Kansas (Wichita) Program	
University of Kansas School of Medicine Program	
University of Puerto Rico School Program	
University of South Alabama Program	
University of South Florida Morsani Program	
University of Tennessee Program	
University of Toledo Program	
University of Vermont/Fletcher Allen Health Care Program	
University of Wisconsin Program	

(Fig. 5). Additionally, approximately 20% of programs in the United States trained more than the average amount of women (i.e., had an average of >20% female trainees over the 5-year period).

Variations in Residency Programs' Female Demographic Characteristics

Residency programs in the United States do not train women at an equal rate. The 30 programs with no female trainees during at least 1 of the 5 years examined (2009-2014) and the 8 programs with no female trainees during each of the 5 years as reported on the GME Track are listed in Table II. The additional 49 programs with >20% women enrolled in at least 1 of the 5 years and the 9

programs with >20% women enrolled during each of the 5 years as reported on the GME Track are listed in Table III.

Earlier Data Compared with Current Data

The chi-square analysis of the original 5 years of GME Track data (2004-2005 through 2008-2009) examining PGY-2 to PGY-5, compared with the subsequent 5 years of GME Track data (2009-2010 through 2013-2014) examining PGY-1 to PGY-5, demonstrated a significant difference in the number of programs training 0 to 1 women per year compared with ≥ 2 women per year ($p < 0.008$). A greater percentage of residency programs have trained ≥ 2 women in the more recent 5-year period (68%) compared with the earlier 5-year period (61%).

TABLE III Orthopaedic Residency Program Sex Profile as Recorded on GME Track Data Reporting >20% Female Residents Enrolled from 2009 to 2014

Programs Reporting >20% Female Residents Enrolled in at Least 1 Year but Not All 5 Years	Programs Reporting >20% Female Residents Enrolled in All 5 Years
Albert Einstein College of Medicine Program	George Washington University Program
Baylor College of Medicine Program	Icahn School of Medicine at Mount Sinai Program
Boston Medical Center Program	Naval Medical Center (San Diego) Program
Carolinas Medical Center Program	New York Presbyterian Hospital (Columbia Campus) Program
Case Western Reserve University/University Hospitals Case Medical Center Program	Stanford University Program
Cedars-Sinai Medical Center Program	University of California (San Francisco) Program
Cooper Medical School of Rowan University/Cooper University Hospital Program	University of Southern California [USC]/LAC [Los Angeles County] + USC Medical Center Program
Dartmouth-Hitchcock Medical Center Program	UPMC [University of Pittsburgh Medical Center] Medical Education Program
Drexel University College of Medicine/Hahnemann University Hospital Program	Washington University/B-JH [Barnes-Jewish Hospital]/SLCH [St. Louis Children's Hospital] Consortium Program
Dwight David Eisenhower Army Medical Center Program	
Grand Rapids Medical Education Partners/Michigan State University Program	
Henry Ford Hospital/Wayne State University Program	
Hospital for Special Surgery/Cornell Medical Center Program	
Howard University Program	
Johns Hopkins University Program	
Maimonides Medical Center Program	
Massachusetts General Hospital/Brigham and Women's Hospital/Harvard Medical School Program	
Naval Medical Center (Portsmouth) Program	
NSLIJ [North Shore]/Hofstra North Shore-LIJ [Long Island Jewish] School of Medicine at Lenox Hill Hospital Program	
Ohio State University Hospital Program	
Palmetto Health/University of South Carolina School of Medicine Program	
Rutgers New Jersey Medical School Program	
San Antonio Uniformed Services Health Education Consortium (SAUSHEC) Program	
Southern Illinois University Program	
St. Louis University School of Medicine Program	
Stanford University Program	
SUNY [State University of New York] Health Science Center at Brooklyn Program	
Tufts Medical Center Program	
Tulane University Program	
Union Memorial Hospital Program	
University at Buffalo Program	
University of Arizona Program	
University of Cincinnati Medical Center/College of Medicine Program	
University of Florida College of Medicine-Jacksonville Program	
University of Kentucky College of Medicine Program	

continued

TABLE III (Continued)

Programs Reporting >20% Female Residents Enrolled in at Least 1 Year but Not All 5 Years	Programs Reporting >20% Female Residents Enrolled in All 5 Years
University of Maryland Program	
University of Massachusetts Program	
University of Minnesota Program	
University of Missouri-Columbia Program	
University of New Mexico Program	
University of Pennsylvania Program	
University of Rochester Program	
University of Texas at Houston Program	
University of Texas Medical Branch Hospitals Program	
University of Utah Program	
University of Washington Program	
Wake Forest University School of Medicine Program	
William Beaumont Army Medical Center/Texas Tech University (El Paso) Program	
Yale-New Haven Medical Center Program	

To verify the data provided by GME Track for the academic years 2009-2010 through 2013-2014, we attempted to contact 39 sites individually via e-mail or telephone because they were below the national average for female residents during the time period studied. Two sites did not have contact information available, as they no longer existed as training programs. Of the 37 programs contacted, 23 programs responded to our inquiry. Five programs had updated program data available on their web sites that could be used to verify the GME Track data. In total, data were confirmed for 28 programs and could not be confirmed for 9 programs. Of the 37 sites contacted, 8 reported no current female faculty and 10 reported

having 1 female faculty member. Twenty-three programs (each program that responded and verified their GME Track data) confirmed having female medical students rotate at their program and that they had ranked women to match.

Fifty-seven programs were listed as having >20% women in their program for at least 1 year or all 5 years during the time period studied (2009 to 2014). Of the 48 programs that we were able to contact, 22 responded to our inquiry. Additional data were gathered through review of the individual programs' web sites and revealed a range of 3 to 4 women currently on faculty for these programs, with approximately 40% holding formal leadership roles (residency program director or chief of a division).

TABLE IV Distribution of U.S. Medical School Orthopaedic Surgery Faculty by Sex and Rank

	Full Professor	Associate Professor	Assistant Professor	Instructor
2014*				
Female sex	49	94	255	71
Total	738	705	1,369	267
Percentage	6.6%	13.3%	18.6%	26.6%
2009†				
Female sex	29	76	183	54
Total	600	607	1,160	236
Percentage	4.8%	12.5%	15.8%	22.9%

*These data were obtained from: Association of American Medical Colleges (AAMC). Table 4A Distribution of women M.D. faculty by department and rank, 2013-2014. 2014 Oct 29. In: The state of women in academic medicine: the pipeline and pathways to leadership, 2013-2014. 2014. https://www.aamc.org/download/411788/data/2014_table4a.pdf. Accessed 2016 May 3. †These data were obtained from our previous publication: Van Heest AE, Agel J. The uneven distribution of women in orthopaedic surgery resident training programs in the United States. *J Bone Joint Surg Am.* 2012 Jan 18;94(2):e9.

GME Track Data

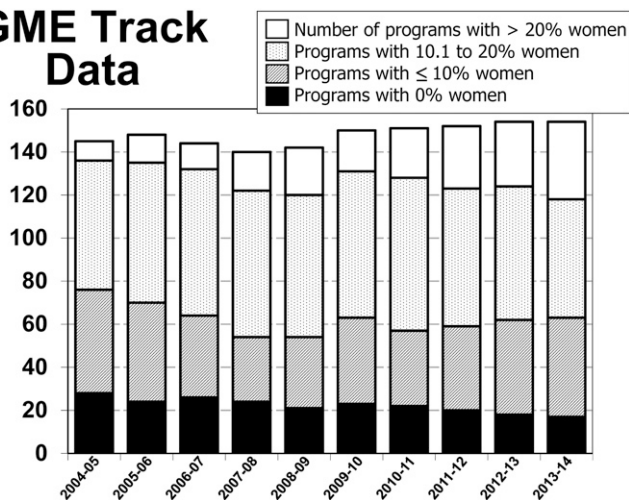


Fig. 5
GME Track data for orthopaedic surgery residency programs in the United States, according to academic year, with 0%, ≤10%, 10.1% to 20%, or >20% women enrolled.

Discussion

The percentage of female medical students choosing to pursue orthopaedic surgery as a specialty choice during the period 2009 to 2014 has remained flatlined at 14%, with only a 1% increase when compared with the 2004 to 2009 period. More than 50 ACGME-accredited orthopaedic surgery residency programs continue to train <10% women, with no change when compared with the 2004 to 2009 GME Track data. Eight programs in the United States reported training no women during any of the 5 academic years profiled from 2009 to 2014. In contrast, in 57 programs in the United States, during at least 1 of the 5 academic years profiled, >20% of their trainees were female.

In contrast to the earlier report, this current study included attempting to contact training programs with both minimal and maximal sex diversity, not only to verify the GME Track data, but also to discuss perceived barriers to and factors attracting women to train in specific programs. In contacting each individual site with minimal sex diversity, only 1 program responded but declined participation. Despite the lack of sex diversity, each program confirmed consistent female rotators and that women had been ranked to match at their program. When questioned directly regarding whether they perceived barriers within their individual programs to matching a woman, the majority thought that no discrete barrier existed. A minority of programs suggested possible barriers, including the following: location of the program (small town), small size of the program, limited number of female faculty, and the challenge to attract more women to train at that program due to the small percentage of female residents in the program.

In contacting programs with >20% female trainees, the majority of programs stated that having women already in the program was the most important factor in attracting additional female residents. These programs also noted that creating an environment that emphasized sex equality was essential. Addi-

tionally, several of these programs noted that many of their female residents had either come from their associated medical school or rotated at their institution prior to matching in the program. Approximately 40% of these programs had women in formal leadership positions within the faculty.

What steps could be taken to increase sex diversity in orthopaedic residency training programs? Certainly the pool of female medical students is not a limiting factor, as nearly 50% of medical students are female. Attracting female medical students to choose orthopaedic surgery as a specialty choice appears to be the limiting factor¹¹. In the past, surgical training was thought to be onerous and was cited as a possible deterrent to choosing orthopaedic surgery as a specialty; however, with women choosing other surgical specialties (neurosurgery, plastic surgery, colorectal surgery, general surgery) at a higher rate than orthopaedic surgery, this reasoning does not appear to be valid in explaining the low rate of women interested in orthopaedic surgery. Furthermore, women have been shown to have performance equal to that of men during residency training¹².

Johnson et al.¹³ examined why medical students choose orthopaedic surgery as a career. Although men had a higher rate of exposures prior to medical school influencing their decision, women relied more on experiences during medical school. This suggests that orthopaedic surgery needs to increase its exposure to medical students to increase its exposure during this critical decision-making time for female medical students. Unfortunately, orthopaedic surgery remains an elective at most medical schools, which may represent a lost opportunity. Bernstein et al.¹⁴ reported that mandatory musculoskeletal instruction during medical school was associated with a 12% increase in application to orthopaedic surgery. Similarly, early exposure of medical students to surgery has a positive correlation with entry into the field. O'Herrin et al.¹⁵ showed a fivefold increase in interest in surgery after a 4-week surgical rotation. Acceptance of women as orthopaedic surgeons has been reported as an important factor in choosing a surgical specialty¹⁶.

The lack of women in positions of leadership has also been cited as a barrier to attracting women¹⁷. As shown in Table IV^{10,18}, <7% of full professors in orthopaedic surgery are women, and only slight increases in female academic faculty have taken place since 2009. Neurosurgery has faced a similar paucity of females choosing neurosurgical careers, and in 2008 the American Association of Neurological Surgeons commissioned a white paper on the recruitment and retention of women in neurosurgery¹⁹. That paper¹⁹ strongly endorsed "promoting women into leadership positions within organized neurosurgery," as well as "fostering the development of female neurosurgeon role models by the training and promotion of competent, enthusiastic, female trainees and surgeons." The importance of mentoring and satisfaction with work culture for retention and promotion of all academic faculty members, but particularly female faculty members, has been documented^{20,21}.

What is the target for diversity in orthopaedic surgery? After passage of civil rights legislation in 1972, the number of female graduates from medical schools has grown until now,

when men and women are equally represented in medicine. However, the percentage of women in surgery has lagged behind those in medical specialties (Table I), and the percentage of women in orthopaedics has lagged behind those in other surgical specialties (Fig. 3). Conversations with women in earlier eras of surgical training reveal the following: when only 1 or 2 women are in a program, each woman is seen as a representative for her entire sex²². When sufficient numbers of women are present in an organization in which each woman is judged on her individual performance and not as a representative of her minority status, then diversity has been achieved. Although no hard numbers exist, achieving a level of 30% of a population has been cited as a goal for diversity to overcome minority status⁹. This should be the goal of orthopaedic surgery as a discipline. Achieving diversity at this level has been shown to provide more perspectives for effective decision-making, more innovation and creativity for organizations, and greater understanding of the patient population that we treat^{8,9}.

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. However, if the data entered into this database were inaccurate or incomplete, the results presented in this study would also have been inaccurate or incomplete. Verification of the data by contacting the programs directly or reviewing the program's web site was attempted for the programs with low numbers of women residents. Comparison of the data from 5 consecutive academic years (2009-2010 through 2013-2014) with our previous report of 5 consecutive academic years (2004-2005 through 2008-2009) was also complicated by the fact that the present report includes PGY-1 to PGY-5 data for total resident count, whereas the previous report included only PGY-2 to PGY-5 data (as the internship year was then considered part of general surgery). Furthermore, the GME Track data only presented a snapshot of each program; they did not track individual residents and they did not report on residents quitting or changing programs. 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. Lastly, 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. Namely, GME Track does not include data regarding application and match rates for female and male medical students, the quality and background of male and female medical student applicants, or the scholastic performance of male and female residents. Further investigation into these factors is warranted.

The findings of this study confirm that ACGME residency programs continue to train women at a rate that has flatlined from 2009 to 2014 at 14%, without improvement from the rate from 2004 to 2009. In the academic years 2009-2010 through 2013-2014, 68% of programs trained ≥ 2 women in their program, whereas in the academic years 2004-2005 through 2008-2009, 61% of programs trained ≥ 2 women in their program. However, residency programs in the United States do not train women at equal rates. From academic years 2009-2010 through 2013-2014, approximately 45% in the United States trained very few women (i.e., had a mean percentage of $<10\%$ female trainees over the 5-year period), and approximately 20% in the United States trained more than an average amount of women (i.e., had a mean percentage of $>20\%$ female trainees over the 5 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 would all be recommended steps toward increasing sex diversity in orthopaedic residency programs. ■

Ann E. Van Heest, MD¹
Felicity Fishman, MD²
Julie Agel, MA¹

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

²Orthopaedics & Rehabilitation, Yale School of Medicine, New Haven, Connecticut

E-mail address for A.E. Van Heest: vanhe003@umn.edu

E-mail address for F. Fishman: felicity.fishman@yale.edu

E-mail address for J. Agel: agelx001@umn.edu

References

- Brotherton SE, Etzel SI. Graduate medical education, 2008-2009. *JAMA*. 2009 Sep 23;302(12):1357-72.
- Brotherton SE, Etzel SI. Graduate medical education, 2009-2010. *JAMA*. 2010 Sep 15;304(11):1255-70.
- Brotherton SE, Etzel SI. Graduate medical education, 2010-2011. *JAMA*. 2011 Sep 7;306(9):1015-30.
- Brotherton SE, Etzel SI. Graduate medical education, 2011-2012. *JAMA*. 2012 Dec 5;308(21):2264-79.
- Brotherton SE, Etzel SI. Graduate medical education, 2012-2013. *JAMA*. 2013 Dec 4;310(21):2328-46.
- Brotherton SE, Etzel SI. Graduate medical education, 2013-2014. *JAMA*. 2014 Dec 10;312(22):2427-45.
- ACGME. ACGME program requirements for graduate medical education in orthopaedic surgery. 2015 Jul 1. http://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/260_orthopaedic_surgery_07012015.pdf. Accessed 2016 May 13.
- Galinsky AD, Todd AR, Homan AC, Phillips KW, Apfelbaum EP, Sasaki SJ, Richeson JA, Olayon JB, Maddux WW. Maximizing the gains and minimizing the pains of diversity: a policy perspective. *Perspect Psychol Sci*. 2015 Nov;10(6):742-8.
- Herring C. Does diversity pay?: Race, gender, and the business case for diversity. *Am Soc Rev*. 2009;74:208-24.
- Van Heest AE, Agel J. The uneven distribution of women in orthopaedic surgery resident training programs in the United States. *J Bone Joint Surg Am*. 2012 Jan 18;94(2):e9.
- Blakemore LC, Hall JM, Biermann JS. Women in surgical residency training programs. *J Bone Joint Surg Am*. 2003 Dec;85(12):2477-80.
- Pico K, Gioe TJ, Vanheest A, Tatman PJ. Do men outperform women during orthopaedic residency training? *Clin Orthop Relat Res*. 2010 Jul;468(7):1804-8.

- 13.** Johnson AL, Sharma J, Chinchilli VM, Emery SE, McCollister Evarts C, Floyd MW, Kaeding CC, Lavelle WF, Marsh JL, Pellegrini VD Jr, Van Heest AE, Black KP. Why do medical students choose orthopaedics as a career? *J Bone Joint Surg Am.* 2012 Jun 6;94(11):e78.
- 14.** Bernstein J, Dicaprio MR, Mehta S. The relationship between required medical school instruction in musculoskeletal medicine and application rates to orthopaedic surgery residency programs. *J Bone Joint Surg Am.* 2004 Oct; 86(10):2335-8.
- 15.** O'Herrin JK, Lewis BJ, Ridders LF, Chen H. Why do students choose careers in surgery? *J Surg Res.* 2004 Jun 15;119(2):124-9.
- 16.** Hill JF, Yule A, Zurakowski D, Day CS. Residents' perceptions of sex diversity in orthopaedic surgery. *J Bone Joint Surg Am.* 2013 Oct 2;95(19):e1441-6.
- 17.** Lewis VO, Scherl SA, O'Connor MI. Women in orthopaedics—way behind the number curve. *J Bone Joint Surg Am.* 2012 Mar 7;94(5):e30.
- 18.** Association of American Medical Colleges (AAMC). Table 4A Distribution of women M.D. faculty by department and rank, 2013-2014. 2014 Oct 29. In: The state of women in academic medicine: the pipeline and pathways to leadership, 2013-2014. 2014. https://www.aamc.org/download/411788/data/2014_table4a.pdf. Accessed 2016 May 3.
- 19.** Benzil DL, Abosch A, Germano I, Gilmer H, Maraire JN, Muraszko K, Pannullo S, Rosseau G, Schwartz L, Todor R, Ullman J, Zusman E; WINS White Paper Committee. The future of neurosurgery: a white paper on the recruitment and retention of women in neurosurgery. *J Neurosurg.* 2008 Sep; 109(3):378-86.
- 20.** Colletti LM, Mulholland MW, Sonnad SS. Perceived obstacles to career success for women in academic surgery. *Arch Surg.* 2000 Aug;135(8):972-7.
- 21.** Wai PY, Dandar V, Radosevich DM, Brubaker L, Kuo PC. Engagement, workplace satisfaction, and retention of surgical specialists in academic medicine in the United States. *J Am Coll Surg.* 2014 Jul;219(1):31-42. Epub 2014 Mar 22.
- 22.** Miller EK, LaPorte DM. Barriers to women entering the field of orthopedic surgery. *Orthopedics.* 2015 Sep;38(9):530-3.