

Research Article

The Demographic Make-up of Orthopaedic Surgery Residents in the United States Post ACGME Merger

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Dr. Mary Mulcahey joined the faculty in the Department of Orthopaedic Surgery at Tulane in April 2017, as the Director of Tulane's Women's Sports Medicine Program. In that role, Dr. Mulcahey has been instrumental in the design, development, and leadership of a comprehensive approach to the care of active women. Dr. Mulcahey is currently President of the Ruth Jackson Orthopaedic Society. Additionally, she is serving on the AANA Board of Directors, the AOSSM education committee, the AJSM Electronic Media Editor-

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Objective

The purpose of this study was to investigate differences in the demographic characteristics of orthopaedic surgery residents in 2021 in regard to sex, degree earned, and regional or medical school affiliation.

Design

The Fellowship and Residency Electronic Interactive Database was used to identify all orthopaedic surgery residency programs in the United States. Resident sex, degree, residency year, and geographic region attended for residency and medical school were collected from each program website.

Results

199 orthopaedic surgery residencies were identified: 153 traditional Accreditation Council for Graduate Medical Education (tACGME) programs, 38 traditional American Osteopathic Association (tAOA) programs, and 8 military programs, which were excluded. 4,095 orthopaedic surgery residents were identified. Females accounted for 16.6% (N=679) of residents, 17.6% (N=620) within tACGME programs and 10.4% (N=59) in tAOA programs ($p<0.001$). The 573 orthopaedic residents with DO degrees accounted for 14% of the residents identified, 97.6% (N=533) of residents in tAOA programs, and 1.1% (N=40) of residents in tACGME programs. Regional data showed that 34.4% (N=1208) of MDs trained in the Northeast, while 41.9% (N=240) of DOs trained in the Midwest.

Conclusion

There has been a slight increase in the representation of females and DOs in orthopaedic surgery residency programs since the mid-2000s; however, data following the ACGME and AOA merger still shows significant predilection for male and MD degree applicants. This study suggests that the Northeast and Midwest regions of the United States train more MDs and DOs, respectively. This finding offers potential data for interested applicants and demonstrates opportunity for more heterogeneity in applicant selection.

INTRODUCTION

Orthopaedic surgery is a heavily male-dominated field compared with other medical specialties (Ramirez and Franklin 2019; Adelani, Harrington, and Montgomery 2019; Day, Lage, and Ahn 2010; Poon et al. 2019; Van Heest and Agel 2012). Although female representation in orthopaedic surgery has increased over the years, it remains the lowest of all surgical specialties (Bennett et al. 2020). In 2018, females comprised only 15.4% of orthopaedic surgery residents, compared to 40.0% in general surgery (Bennett et

al. 2020). Another less-discussed disparity in orthopaedic surgery exists in the medical degrees earned by orthopaedic surgeons.

A majority of orthopaedic surgeons hold Medical Doctor (MD) degrees, with a limited number holding Doctor of Osteopathy (DO) degrees. This is partially due to the long-standing history of osteopathic physicians having a predilection towards primary care specialties. While a majority of DOs still pursue primary care specialties such as internal medicine and family medicine, in recent decades, DOs have begun branching out into surgical subspecialties.

ial Board, and she was selected for the AOSSM Traveling Fellowship to Europe in April 2022. Dr. Mulcahey is the team physician for Tulane's Women's Indoor and Beach Volleyball teams, the Big Easy Rollergirls, New Orleans Women's Rugby (the Halfmoons), as well as several local all girls' high schools.

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Despite this, bias against DOs in the field of orthopaedic surgery still remains a concern (*National Resident Matching Program, Results and Data: 2021 Main Residency Match® 2021*).

Up until 2020, there was a separate residency match process for allopathic and osteopathic medical students: the American Osteopathic Association (AOA) for DOs and the Accreditation Council for Graduate Medical Education (ACGME) for MDs. However, osteopathic medical students were able to forego the AOA match to participate in the ACGME match if they also completed United States Medical Licensing Examinations. In 2020, the AOA and the ACGME merged into a single accreditation and match process through the National Residency Match Program (NRMP), as both governing bodies agreed that the training between the two pathways were comparable.

Orthopaedic surgery residency is one of the most competitive specialties for medical students to match into every year (Brendan Murphy News Writer 2018). It is estimated that there are only 868 orthopaedic surgery training positions offered annually, with 1,289 applicants, according to 2021 National Resident Matching Program (NRMP) (*National Resident Matching Program, Results and Data: 2021 Main Residency Match® 2021*). Therefore, a medical student's choice in where they would like to pursue training is often limited. Previous studies have demonstrated that geographic location is an important factor in ranking orthopaedic residency programs (Nuthalapati, Jackson, and Owen 2004; Sanfilippo, Sharkey, and Parvizi 2006; Huntington, Haines, and Patt 2014).

There is a paucity of literature regarding the current representation of DOs in orthopaedic surgery residency and the geographical trends of orthopaedic residents, both osteopathic and allopathic, in the US. The purpose of this study was to investigate differences in the demographic characteristics of orthopaedic surgery residents in 2021 in regard to sex, degree earned, and regional or medical school affiliation. We hypothesized that there continues to be underrepresentation of the female sex, the DO degree, and that demographic regions plays a role in retention of orthopaedic residents due to proximity to family support and needs in the 9 years of medical training.

METHODS

In January 2021, all Accreditation Council for Graduate Medical Education (ACGME) accredited orthopaedic resi-

dency programs were identified using the American Medical Association's residency database, Fellowship and Residency Electronic Interactive Database (FREIDA) (<https://freida.ama-assn.org>). The annually updated and publicly accessible websites of the accredited programs were then individually searched to determine each resident's sex, degree, residency year, and medical school attended. The data collected for each resident was then de-identified. Residency programs and medical schools were assigned a region based on the Agricultural Research Service's classification of regions in the US, with an added sixth region to include international medical graduates (United States Department of Agriculture, n.d.). Each resident's program and medical school were then compared to determine if they remained in the same program, same state, and/or same region. Resident regional information was then compared across type of degree earned (MD vs. DO) and sex. Exclusion criteria for the study included programs that did not provide information on the sex, degree, and medical school attended. The collected data were analyzed using Microsoft Excel (2013/2016) and SPSS software, version 25. Chi Squared and ANOVA tests were used to compare groups. No sources of funding have been granted for this study.

RESULTS

The FREIDA search identified 199 ACGME-accredited orthopaedic surgery residency programs. Of the 199 total programs, 153 (76.8%) were traditionally allopathic, 38 (19%) traditionally osteopathic, and 8 (4%) military. Sixteen programs did not include resident information (eight civilian programs and all eight military programs) and thus were excluded. The remaining 183 programs' websites provided information for 4,095 residents, averaging about four residents accepted to each program per year.

Of the 4,095 residents identified, 3,416 (83.4%) were male, while 679 (16.6%) were female. An MD degree was received by 3,501 (85.5%) of the residents, while 572 (14%) were DOs, 12 (0.2%) were MD/PhDs, and 1 (0.02%) was a DO/PhD. For comparative analysis, resident degrees were simplified to MD or DO, resulting in 3,513 MDs (86.0%) and 573 DOs (14.0%). Interns accounted for 823 (20.1%) of the residents, 830 (20.3%) were second year residents, 837 (20.4%) were third year residents, 811 (19.8%) were fourth year residents, 788 (19.2%) were fifth year residents, and 6 (0.1%) were research residents.



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Table 1. Comparison of MD and DO Orthopaedic Surgery Residents at Traditional ACGME and AOA Programs

	MD	DO	P-Value
ACGME (N, %)	3500 (98.9%)	40 (1.1%)	<0.001
AOA (N, %)	13 (2.4%)	533 (97.6%)	<0.001

Note. ACGME, The Accreditation Council for Graduate Medical Education; AOA, American Osteopathic Association; DO, Doctor of Osteopathic Medicine; MD, Doctor of Medicine.

Table 2. Comparison of Degrees Earned Between Male and Female Orthopaedic Surgery Residents

	Male	Female	P-Value
MD (N, %)	2896 (82.4%)	617 (17.6%)	<0.001
DO (N, %)	511 (89.2%)	62 (10.8%)	<0.001

Note. MD, Doctor of Medicine; DO, Doctor of Osteopathic Medicine

Residents with DO degrees comprised the majority of residents in traditional AOA programs and residents with MD degrees comprised the majority of residents in traditional ACGME programs (97.6% and 98.9%, $p<0.001$, respectively). A higher proportion of residents with MD degrees attended traditional AOA orthopaedic surgery residency programs than DOs attended traditional ACGME programs (2.4% vs. 1.1%, respectively, $p<0.001$) (Table 1).

There were fewer females with DO degrees than MD degrees (10.8% vs. 17.6%, respectively, $p<0.001$) (Table 2). Similarly, there were fewer females in traditional AOA programs than ACGME programs (10.6% vs. 17.5%, respectively, $p<0.001$) (Table 3).

689 (18%) residents were in the same institution as their medical school, 1249 (31%) residents remained in the same state as their medical school, and 2249 (59%) residents stayed in the same region as their medical school.

The largest proportion of orthopaedic residents trained in the Northeast (33.4%) and the least number of residents were in the Plains region (10.3%) (Figure 1). When residents were divided into degrees earned, the majority of MDs trained in the Northeast (34.4%); however, the largest proportion of DOs trained in the Midwest (41.9%). When divided by sex, the greatest proportion of both female and male residents trained in the Northeast (33.9% and 32.7%,

Table 3. Comparison of Male and Female Orthopaedic Surgery Residents at Traditional ACGME and AOA Programs

	Male	Female	P-Value
ACGME (N, %)	2920 (82.5%)	620 (17.5%)	<0.001
AOA (N, %)	496 (89.4%)	59 (10.6%)	<0.001

Note. ACGME, The Accreditation Council for Graduate Medical Education; AOA, American Osteopathic Association

respectively). The Northeast also retained the most residents at the same institution, same state, and same region as their medical school (Table 4).

When DO and MD residents were compared, the Pacific West was the only region that did not differ between groups. The Northeast, Southwest, and Plains regions trained more MDs than DOs ($p=0.002$, $p=0.003$, and $p<0.001$, respectively). The Midwest had more DO residents, comparatively ($p<0.001$). More MDs remained in the same institution affiliated with their medical school and within the same state as their medical school compared to DOs ($p<0.001$ and $p=0.023$). No difference existed between groups with regards to remaining in the same region as their medical school (Table 5).

When residents were compared across sexes, males were more likely to remain in the same region as their medical school as compared to females (59.5% vs. 55.2%, $p=0.041$). However, no difference existed between sexes in regards to remaining within the same institution or state as their medical school. A higher percentage of female residents trained in the Northeast than males (36.8% vs. 32.7%, $p=0.038$). No other regional differences were observed between male and female orthopaedic surgery residents (Table 6).

DISCUSSION

Despite receiving very similar medical training, osteopathic medical graduates are less favored than their allopathic counterparts for positions in orthopaedic residencies. With only one fifth of the civilian residencies (38 vs 153) previously dedicated solely to osteopathic graduates now open to allopathic applicants, opportunities for DOs in orthopaedic surgery are becoming more limited. Our study revealed that DOs currently represent 14% of the orthopaedic surgeons in training, with only 1.1% in traditional ACGME programs.

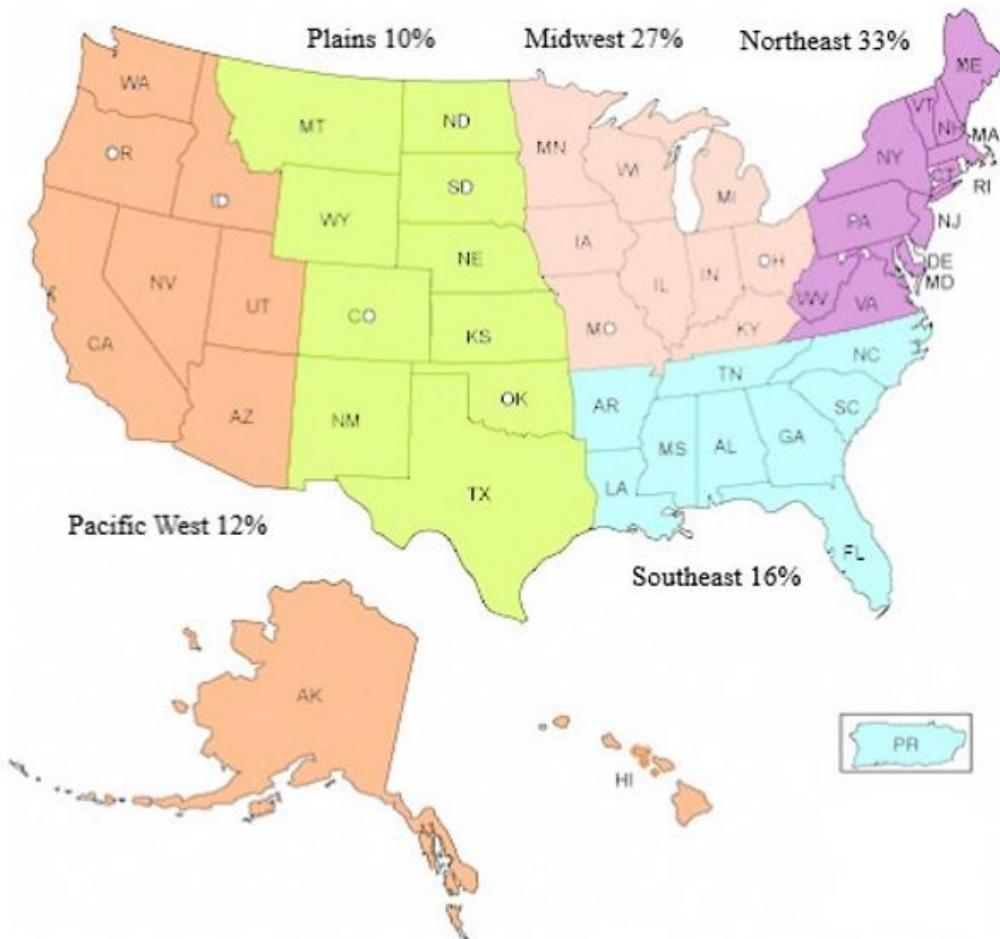


Figure 1. Regional Map of Orthopedic Surgery Residency Position Percentages.

Figure 1 contains a map of the United States of America, with states color coded by region. Five regions are included: the Northeast, the Southeast, the Midwest, the Plains, and the Pacific West. Above or below each region is the percentage of residents within that respective region.

When averaging DO match rates to traditional ACGME programs from 2012 to 2019, DOs represented less than 1.0% of all matches into competitive surgical specialties, with only 0.5% of DOs in orthopaedic surgery programs (Craig et al. 2021). In 2019, the year before the combined match, 75.9% of total ACGME applicants were senior MD students and 24.1% were senior DO students ("Table 4: Applicants in the Matching Program, 2015 – 2019" 2019). Aiyer et al. reviewed the 2019 NRMP orthopaedic surgery match data and detailed that of the 752 ACGME-accredited orthopaedic surgery postgraduate year positions filled, only 15 (2%) were from students attending US osteopathic medical schools; this reflects a lack of osteopathic residents matching into traditionally allopathic orthopaedic residencies (Aiyer et al. 2020). Moreover, 727 (96.6%) of the positions offered were filled by US allopathic medical students and 10 students (1.3%) were graduates of international medical schools (Aiyer et al. 2020). This, however, is triple the number of osteopathic medical students that garnered allopathic orthopaedic residency positions in 2016, 2017, and 2018 ("Table 11: Osteopathic Students/Graduates Matched to PGY-1 Positions by Specialty,* 2015 – 2019" 2019).

Following the first year of the combined DO/MD match, NRMP match data demonstrated 81.3% (686 of 844) of orthopaedic surgery positions were filled by MD seniors, and 13.2% (112 of 844) by DO seniors ("Table 1A: Match Summary for MD Seniors, 2020" 2020; "Table 1B: Match Summary for MD Seniors" 2020). While this rise in percentage of orthopaedic residency positions obtained by DOs from 2% to 13% may seem like a substantial improvement in osteopathic students matching into orthopaedic surgery residency programs, the NRMP data does not distinguish between traditional osteopathic and traditional allopathic programs. The addition of traditional osteopathic programs to the NRMP match inflates the percentage of DOs in orthopaedic surgery match data. Distinguishing the program types as traditionally osteopathic or not helps illustrate how many DOs are accepted into traditional MD programs, which serves as an indicator of whether there is change in osteopathic bias.

While osteopathic medical students have participated in the ACGME match for many years, allopathic medical students have only recently begun applying to programs that were traditionally osteopathic. Despite their recent ability to match into traditional osteopathic programs, MDs still comprise a larger percentage of residents at traditional

Table 4. Demographics and Regional Distribution of U.S. Orthopaedic Surgery Residents.

	Northeast	Southeast	Midwest	Plains	Pacific West	IMG	Total N
Residents, N (%)	1367 (33.4%)	687 (16.8%)	1107 (27%)	420 (10.3%)	515 (12.6%)	0 (0%)	4096
MD, N (%)	1208 (34.4%)	615 (17.5%)	858 (24.4%)	400 (11.4%)	432 (12.3%)	0 (0%)	3513
DO, N (%)	159 (27.7%)	72 (12.6%)	240 (41.9%)	20 (3.5%)	82 (14.3%)	0 (0%)	573
Male, N (%)	1117 (32.7%)	580 (17%)	942 (27.6%)	350 (10.2%)	427 (12.5%)	0 (0%)	3416
Female, N (%)	250 (33.9%)	165 (22.4%)	165 (22.4%)	70 (9.5%)	87 (11.8%)	0 (0%)	737
Same Institution: Yes, N (%)	218 (31.6%)	129 (18.7%)	173 (25%)	101 (14.7%)	68 (9.9%)	0 (0%)	689
Same State: Yes, N (%)	450 (36%)	186 (14.9%)	326 (26.1%)	174 (13.9%)	113 (9%)	0 (0%)	1249
Medical School Region, N (%)	1248 (32.6%)	758 (19.8%)	964 (25.2%)	465 (12.2%)	335 (8.8%)	53 (1.4%)	3823
Same Region as Medical School: Yes, N (%)	866 (38.5%)	381 (16.9%)	595 (26.5%)	236 (10.5%)	171 (7.6%)	0 (0%)	2249

Note. MD, Doctor of Medicine; DO, Doctor of Osteopathic Medicine; IMG, International Medical Graduate

Table 5. Regional Distribution of Orthopaedic Surgery Residents Across Degree Earned.

	MD	DO	P-Value
Northeast	1208 (34.4%)	159 (27.7%)	0.002
Southeast	615 (17.5%)	72 (12.6%)	0.003
Midwest	858 (24.4%)	240 (41.9%)	<0.001
Plains	400 (11.4%)	20 (3.5%)	<0.001
Pacific West	432 (12.3%)	82 (14.3%)	0.178
Same Institute: Yes, N (%)	653 (19.6%)	36 (7.2%)	<0.001
Same State: Yes, N (%)	1109 (33.3%)	140 (28.2%)	0.023
Same Region as Medical School: Yes, N (%)	1968 (59.1%)	281 (56.5%)	0.276

Note. MD, Doctor of Medicine; DO, Doctor of Osteopathic Medicine

AOA programs (2.4%) than DOs in traditional ACGME orthopaedic surgery residency programs (1.1%). Also of note, the NRMP match data for 2021 reveals a decrease in the number of osteopathic medical students garnering positions in orthopaedic surgery residency programs (12.3% DOs and 80.5% MDs), indicating persistent challenges for osteopathic students interested in orthopaedic surgery, and may elucidate the prospect that the combined match has actually decreased DOs matching into orthopaedic surgery

Table 6. Regional Distribution of Orthopaedic Surgery Residents Across Sex.

	Male	Female	P-Value
Northeast	1117 (32.7%)	250 (36.8%)	0.038
Southeast	580 (17%)	107 (15.8%)	0.437
Midwest	942 (27.6%)	165 (24.3%)	0.079
Plains	350 (10.2%)	70 (10.3%)	0.945
Pacific West	427 (12.5%)	87 (12.5%)	0.822
Same Institute: Yes, N (%)	565 (17.7%)	124 (19.4%)	0.324
Same State: Yes, N (%)	1049 (32.9%)	200 (31.3%)	0.409
Same Region as Medical School: Yes, N (%)	1896 (59.5%)	353 (55.2%)	0.041

(“Table 1A: Match Summary for MD Seniors” 2021; “Table 1B: Match Summary for DO Seniors” 2021).

Low osteopathic representation is also prevalent in other surgical subspecialties. Etheart et al. reviewed DO matches in neurosurgery, otolaryngology (ENT), plastic surgery, and general surgery in 2020 (Etheart et al. 2021). Their data revealed that no DOs matched as a PGY-1 into plastic surgery and of the DOs applying to neurosurgery, 16.7% of the DO applicants were matched compared to 74.4% of the MD applicants matched. ENT and general surgery had more favorable DO match outcomes, but still comprised a lesser per-



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centage than their MD counterparts. ENT matched 51.5% of the DO applicants and 73.6% of the MD applicants. General surgery matched 59.4% DO applicants and 75% MD applicants (Etheart et al. 2021).

In addition to residents with DO degrees, women are also underrepresented in orthopaedic surgery. Although female representation in orthopaedic surgery has increased over the past several years, it remains the lowest of all surgical specialties (Bennett et al. 2020). Poon et al. reported a modest increase of female orthopaedic surgery residents from 10.9% to 14.4% between 2006 to 2015 (Poon et al. 2019). Bennett et al. observed trends regarding percentage of female residents in surgical subspecialties over 10 years. In 2008, they demonstrated that the lowest female representation was 11.2% in neurosurgery, followed by 12.4% in orthopaedic surgery (Bennett et al. 2020). 10 years later, in 2018, females represented 17.8% of neurosurgery residents and 15.4% orthopaedic residents, further illustrating how slow orthopaedic surgery is to increase its female representation (Bennett et al. 2020). The number of females with DO degrees in orthopaedic surgery is even lower. Our study revealed that females, both allopathic and osteopathic, comprised 16.6% of the orthopaedic residency classes across all 5 years of training. However, females with DO degrees only comprised 1.5% of residents.

The lack of females in orthopaedic surgery could be due to a large variety of reasons. Schroeder et al. assessed medical students' and interns' interests and perceptions of orthopaedic surgery and found that fewer women find the specialty interesting and believe it is too time consuming and distracting from time with family (Schroeder et al. 2014). Similarly, Baldwin et al. evaluated factors affecting interest in orthopaedics among female medical students and revealed there was a deterrence due to negative perceptions of male dominance and difficult lifestyle during and after training with regards to balancing career and family (Baldwin et al. 2011). Hern et al. researched the prevalence of illegal questions in residency interviews and found that females are more frequently asked illegal questions and thus rank those programs lower, or not at all (Hern et al. 2013). Additionally, O'Connor et al. assessed female medical student's interest in orthopaedic surgery and noted

that a large detractor was that there are fewer opportunities for female mentorship in the specialty (O'Connor 2016).

Orthopaedic surgery residencies have varying regional densities across the US. Nuthalapaty et al. and Sanfilippo et al. demonstrated that geographic location is the second most important factor when choosing a residency behind program "fit" and early surgical/clinical experience, respectively (Huntington, Haines, and Patt 2014; United States Department of Agriculture, n.d.). Cox et al. studied geographic trends of allopathic orthopaedic residents in 2015–2016 and found that 1,220 of 2,614 (47%) study participants matched into the same geographical division as their medical school and 817 (31%) matched within the same state (Cox et al. 2018). The present study found that 2,249 (59%) remained in the same region as their medical school and 1,249 (31%) within the same state. Cox et al.'s overall percentage of residents who matched into orthopaedic surgery affiliated with their respective medical school was 21%, which is similar to the present study's 18%, which accounts for both allopathic and osteopathic graduates.

Our present study validates our hypothesis that there is in fact a slight increase in female representation in orthopaedic surgery residency. With regards to regional preferences, our hypothesis is validated that a majority of residents will remain in the same demographic region as their medical school, while 1 in 3 residents will remain in the same state as their medical school. There is no difference between this pattern of behavior across sex or degrees earned. This further highlights the potential for recruitment of orthopaedic residents in certain regions which may have lack of access to healthcare. We suspect that the 4 years in medical school, followed by 5 years in orthopaedic surgery residency incentivizes potential trainees to stay within the region, possibly closer to family support and familiarity of the community.

There are several limitations to this study. All the information was obtained from orthopaedic surgery program websites. Websites can be inaccurate and are not updated frequently. Oladeji et al. found that there is a lack of consistency regarding the content presented on orthopaedic residency websites (Oladeji et al. 2015). However, the onset of the COVID-19 pandemic, the transition to virtual inter-



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views, and the limitation for away rotations has motivated programs to provide more updated and accurate information on their websites.²⁹ Finally, program data was missing for 16 of the 199 programs. This additional data may have affected the percentage of female and osteopathic residents as well as the geographic percentages reported. Several programs did not provide information on the geographic location where their residents attended medical school. Also, as aforementioned, osteopathic medical schools are often established in a community setting, without university affiliation, and this may decrease the statistical percentage of osteopathic students who match within the same state or institution. We were unable to determine the percentage of DOs matching in traditionally osteopathic orthopaedic surgery residency programs prior to the merger. The American Osteopathic Association historically did not publish specific statistics of the osteopathic match in the same format provided by the National Resident Program Matching (NRMP). If this information were to be available, it could provide a more comprehensive picture of the orthopaedic surgery match for osteopathic students before and after the merger.

Moreover, at the time of data acquisition, the osteopathic and allopathic residencies had recently merged, and this may skew the data to reflect more traditional applica-

tion patterns, where DO students applied to traditionally DO programs and MD students applied to traditionally MD programs, with both degrees having minimal cross over. Future studies could benefit from prospectively investigating applicant preference for training location and comparing where they matched once the merger period has had time to equilibrate. Additionally, similar studies could be conducted in other specialties to see if there is a correlation regarding region location and degree earned in other competitive specialties when it comes to applicant selection.

CONCLUSION

There has been a slight increase in the representation of females and DOs in orthopaedic surgery residency programs since the mid-2000s; however, data following the ACGME and AOA merger still shows significant predilection for male and MD degree applicants. This study suggests that the Northeast and Midwest regions of the United States train more MDs and DOs, respectively. This finding offers potential data for interested applicants and demonstrates opportunity for more heterogeneity in applicant selection.

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