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AOA Critical Issues in Education

Racial and Sex Disparities in Resident Attrition in Orthopaedic Surgery

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Background: Studies have suggested that female individuals and individuals from backgrounds under-represented in medicine (URiM) are at increased risk of attrition during residency. This likely exacerbates the lack of diversity in our field. The aims of this study were to (1) characterize demographic composition in orthopaedic residency from 2001 to 2018 and (2) determine the race/ethnicity and identify any disparities.

Methods: Demographic and attrition data from 2001 to 2018 were obtained from the Association of American Medical Colleges. Attrition data comprised the following categories: withdrawals, dismissals, and transfers to another specialty. Analysis compared demographic composition and determined attrition rates with subgroup analysis by race/ethnicity and sex.

Results: From 2001 to 2018, female orthopaedic residents increased from 8.77% to 15.54% and URiM residents from 9.49% to 11.32%. The overall and unintended attrition rates in orthopaedic surgery were 3.20% and 1.15%, respectively. Among female residents, the overall and unintended attrition rates were 5.96% and 2.09% compared with 2.79% and 1.01%, respectively, in male residents. URiM residents had overall and unintended attrition rates of 6.16% and 3.11% compared with 2.71% and 0.83%, respectively, for their White counterparts. Black/African American residents had an attrition rate of nearly 10%. Female residents averaged 12.9% of all residents but 24% of those leaving orthopaedics. URiM residents were 10.14% of all residents but 19.51% of those experiencing attrition. In logistic regression models, female residents had a relative risk (RR) of 2.20 ($p < 0.001$) for experiencing all-cause attrition and 2.09 ($p < 0.001$) for unintended attrition compared with male residents. Compared with their White male counterparts, URiM residents had a RR for overall and unintended attrition of 2.36 and 3.84 ($p < 0.001$), respectively; Black/African American residents had a RR for the same of 3.80 and 7.20 ($p < 0.001$), respectively.

Conclusion: Although female resident percentage has increased, orthopaedics continues to train fewer female surgeons than all other fields. Female and URiM residents in orthopaedic surgery are disproportionately affected by attrition. While recruitment has been the primary focus of diversity, equity, and inclusion efforts, this study suggests that resident retention through appropriately supporting residents during training is equally critical.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSOA/A524).

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Introduction

Orthopaedic surgery continues to lag behind other surgical specialties in both racial diversity and gender diversity[1]. Although female representation in orthopaedic residency programs has increased over time, the rate of increase remains the lowest among surgical specialties[2,3]. Similarly, minority (non-White) representation in orthopaedic surgery averaged between 20% and 25% in the 2000's but was significantly less racially diverse than all other specialties examined in studies by Poon et al. and Okike et al.[2,4]. Across orthopaedic programs, there is wide variation in the proportion of female residents and trainees under-represented in medicine (URiM)[5].

There are limited studies on resident attrition in orthopaedics, with some citing attrition rates as low as 0.59%[6]. These are comparable with annual attrition rates in plastic surgery (0.85%-2.15%) and otolaryngology (1.2%)[7,8]. Other specialties such as general surgery and neurosurgery have reported rates of attrition as high as 18% and 17%, respectively[9,10]. When comparing attrition rates between male and female orthopaedic surgery residents, several studies have demonstrated that female residents have significantly higher rates of attrition compared with male residents and that more female residents voluntarily leave for personal reasons than their male counterparts[6,11].

To achieve a more diverse and representative orthopaedic surgery workforce, a better understanding of trends in racial/sex diversity and resident attrition is essential. Therefore, this study aimed to investigate the trends in racial and sex diversity and attrition rates in orthopaedic surgery training programs from 2001 to 2018.

Materials and Methods

Data Source

This study was institutional review board exempt because of the analysis of deidentified information. The Association of American Medical Colleges (AAMC) administers yearly surveys to programs regarding resident training status through the Graduate Medical Education (GME) Track. The data set representing residents enrolled in a surgical residency program from 2001 to 2018 was requested. The data set included information on resident demographics, years in residency, a unique resident identification code, a program identification code, medical school(s) of affiliation, surgical subspecialty, age category/range at the start of training, reported race/ethnicity, sex, and attrition status. Programs accredited by the Accreditation Council for Graduate Medical Education (ACGME) were included; however, not all ACGME-accredited programs participate in the GME Track (response rates estimated to be 80%-95% of all surgical training programs).

Over the course of 2001 to 2018, orthopaedic surgery training programs reported 61,584 resident training statuses representing 15,215 unique residents. Training status was verified for each resident annually by the participating training program. For example, residents in a 5-year training program would have 5 reports/statuses (or more if additional years were pursued). Residents who underwent attrition before the end of a 5-year program would only have reports of the participated years of training.

Race and Ethnicity Data

Race/ethnicity data were either self-reported (e.g., the Electronic Residency Application Service) or obtained through institutional/employment records. During the study period, the AAMC noted several changes in the collection of race/ethnicity data. Before the 2002 to 2003 academic year, an individual could only identify with a singular race/ethnicity category. From 2003 to 2013, the AAMC collected race/ethnicity data in 2 questions: the first inquired about the race or races with which an individual identified and the second asked about Hispanic origin. Since the start of the 2013 academic year, the AAMC has collected race/ethnicity data allowing individuals to select a combination of races and Hispanic origin.

For purposes of this study, race/ethnicity information was organized into the following categories: American Indian/Alaskan Native, Asian, Black/African American, Hispanic, Native Hawaiian/Pacific Islander, White, Other, Unknown, and Multiracial/multiethnicity. URiM was defined as American Indian/Native American, Black/African American, Hispanic, Native Hawaiian/Pacific Islander, or any multiracial/multiethnic individual when one or more are from the preceding racial and ethnic categories.

Attrition Data

Resident attrition data were obtained from the AAMC for the 2001 to 2018 academic years in conjunction with the demographic data. Attrition was reported on an individual basis for each resident. Two reported categories were used to describe attrition including (1) withdrawal and dismissal, which encompassed changing careers (leaving medicine), health/family reasons, leaving country/US VISA issues, military obligations, other/unknown, and some unknown quantity of involuntary dismissals/fired (not formally tracked by the AAMC), and (2) transfer to another specialty. Transfers within the same specialty to another program were not reported. Unintended attrition is a category defined by the authors that encompasses all withdrawals and dismissals, except for changing careers (Supplementary Table I, http://links.lww.com/JBJSOA/A525).

Attrition data were presented using the individual resident as the observation unit for frequency counts and analysis. This unit of observation was achieved by collapsing all responses provided by the individual, yielding a binary (yes/no) summary of attrition/dismissal events for the individual resident. For example, a resident who underwent attrition during the third year of residency would represent 3 annual responses but only 1 attrition event. For an individual with more than 1 event (e.g., transferring specialties and later choosing to leave medicine entirely), only the first-ever attrition event was counted.

Statistical Analysis

Data processing and data set management was performed with SAS 9.4 (SAS institute), and statistical analysis was performed with STATA 13.0/SE (StataCorp LP). Two-sided p-values at an α level of 0.05 were defined as the limits for statistical significance, and 95% confidence intervals were reported. Data were analyzed in 2 schemes: For trend over

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time, survey responses were used because this method could better delineate trend over time. For attrition rate, the individual resident was used as the observation unit by collapsing all responses by the individual because this method better represents overall attrition rate and relative risk (RR) in logistic regression models. A trained statistician was directly involved with statistical evaluation.

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This project was aided by a grant from the Orthopaedic Research and Education Foundation with funding made possible by the J. Robert Gladden Orthopaedic Society.

Results

General Demographic Analysis

From 2001 to 2018, the average percentage of female residents in orthopaedic surgery increased from 8.77% to 15.54% (Fig. 1). Race and ethnicity analysis revealed a decreasing average percentage of Black/African American, Hispanic, American Indian/Native American, Pacific Islander, and White residents and an increasing average percentage in the multiracial/multiethnicity category, although this is likely, in part, because of updates in the racial/ethnicity identifying options in the AAMC questionnaire. The average percentage of Asian residents remained constant from 13.01% in 2001 to 13.1% in 2018. Despite a decreasing trend in the average percentage of White residents, they remain the largest demographic (>70%) among orthopaedic surgery residents (Fig. 2). There was a slight increase in URiM residents from 9.49% to 11.32% in orthopaedic surgery over the study period (Figs. 3 and 4).

In our analysis of female trainees in orthopaedic surgery, there were 9 programs (4.76%, total number of programs = 189) without any female residents over the study period, 53 (28%) with 5% to 10% female trainees, 62 (33%) with 10% to 15%, 35 (18.5%) with 15% to 20%, 13 (7%) with 20% to 25%, and 7 (3.7%) with 25% to 50% female resident representation.

Regarding URiM representation, 14 programs (7.4%) did not have any URiM trainees during the study period. There were 28 programs (15%) with 0% to 5% URiM trainees, 81 (43%) with 5% to 10%, 42 (22%) with 10% to 15%; 14 (7.4%) with 15% to 20%, and 10 (5.3%) with 20.00% to 98.84% URiM resident representation.

Attrition

Table I presents the demographic composition of orthopaedic surgery residents and attrition rates within sex and racial/ethnic subgroups. The overall attrition rate of residents in orthopaedic surgery was 3.20%, with an average unintended attrition rate of 1.15% from 2001 to 2018, with a trend toward slightly decreasing rates over time.

The attrition rate of female orthopaedic residents was significantly higher compared with that of male residents (5.96% vs. 2.79%, $p < 0.001$), and the unintended attrition rate was twice as high (2.09% compared with 1.01%, $p < 0.001$). Table II presents the RR of attrition by sex and racial/ethnic subgroups. Compared with male residents, the attrition and unintended attrition RRs for female orthopaedic residents were 2.20 (95% confidence interval [CI]: 1.78-2.73, $p < 0.001$) and 2.09 (95% CI: 1.47-2.97, $p < 0.001$), respectively. The RRs for Black/African American residents to experience attrition and unintended attrition were significantly elevated at 3.80 and 7.20 ($p < 0.001$), respectively, compared with White residents. Among female URiM residents, Black/African American female residents (0.60% of all residents) had the highest attrition and unintended attrition RRs at 3.64 and 6.74 ($p < 0.001$, as compared with White male residents), respectively, as presented in Table II. Similarly, Black/African American male residents (3.44% of all residents) also had the highest attrition and unintended attrition RRs at 3.77 and 7.16 ($p < 0.001$), respectively.

Hispanic residents did not have a significantly elevated RR for attrition (1.06, $p = 0.85$) or unintended attrition (1.58, $p = 0.32$) compared with White residents. In aggregate, URiM residents had a significantly elevated RR for attrition (2.36, $p < 0.001$)

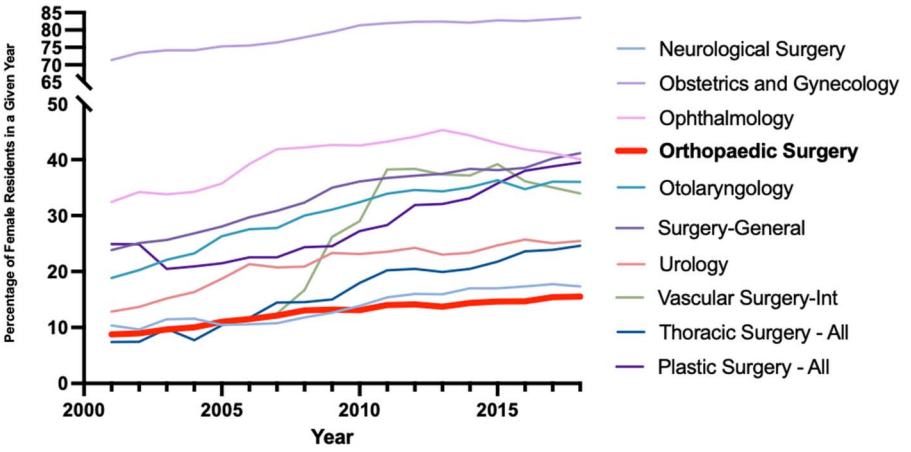

Fig. 1

Average percentage of female residents in orthopaedic surgery vs. other surgical specialties, 2001 to 2018. Illustration of the trend over time of female representation in surgical training programs from 2001 to 2018. Orthopaedic surgery remains the lowest among all surgical subspecialties.

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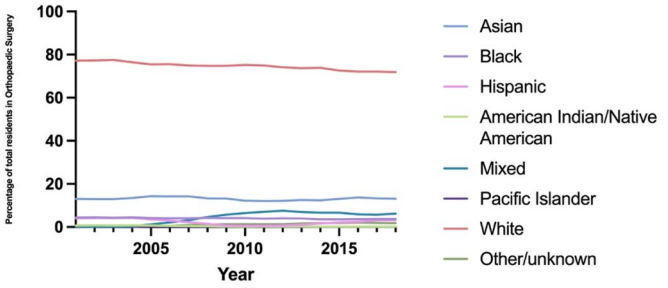

Fig. 2

Racial composition of orthopaedic surgery residents, 2001 to 2018. A depiction of the demographic makeup of orthopaedic trainees over the study period.

when compared with White residents and a nearly 4-fold unintended attrition risk (RR: 3.83, $p < 0.001$). In addition, URiM residents represented, on average, 10.14% of the total residents during the study period but 19.51% of those experiencing attrition. Black/African American residents represented only 4.05% of total orthopaedic surgery residents but accounted for 12.11% of residents who underwent attrition.

Discussion

Concerted emphasis on recruiting a more diverse and representative orthopaedic residency cohort has resulted in an increase in the percentage of female trainees over the past 18 years. Despite this growth, orthopaedic surgery continues to have the lowest percentage of female residents among surgical subspecialties[12]. The percentage of URiM residents has been gradually increasing, albeit at a slower rate than female residents. Although much attention and resources have been devoted to the recruitment of residents, there has been limited emphasis placed on retaining trainees once they are in residency. We found that the RR of attrition for female orthopaedic residents is more than double than that of their male counterparts, comparable with studies from other surgical fields such as neurosurgery, which reported a 3-fold female resident attrition rate compared with their male colleagues[10]. This is in contrast to general surgery training outcomes where a meta-analysis of 26 studies for training years 1990 to 2015 did not demonstrate a significantly increased attrition rate among female residents[13].

Van Heest et al. highlighted the significant variation in gender diversity across US orthopaedic residencies[14]. Some programs did not train any female residents, whereas others had more than 20% enrolled at times. In our study, there were 9 programs (4.76%) without any female residents from 2001 to 2018 and most (83%) comprised less than 20% female trainees. Similarly, 14 programs (7.41%) had no URiM residents, and most (58%) had less than 10%. Although an analysis of the effect of resident cohort and faculty diversity on resident attrition was beyond the scope of this study, it remains a critical area of concern and should be further investigated.

URiM residents had a 2-fold risk of attrition compared with White residents while subgroup analysis identified both female and male Black/African American residents to have the highest risk of attrition and unintended attrition. Keshinro et al. revealed that under-represented groups (non-White/Asian) had significantly higher attrition rates in general surgery[15]. Both our study and the work by McDonald et al. demonstrated that a disproportionate percentage of under-represented residents experienced attrition relative to their composite percentage of total residents in orthopaedic surgery[5,12]. This disparity was particularly evident among Black/African American residents who represented only 4% of all orthopaedic residents but accounted for 12% of those experiencing attrition. The disproportionate attrition rate and lack of representation in orthopaedics may have serious implications for the retention of URiM residents because mentoring plays an important role in residents' personal and career development[16].

Other studies have explored the presence and effects of microaggressions, male culture, and misidentification and highlighted the lack of mentoring and harassment faced by female and URiM orthopaedic surgeons[17-23]. In a study by Brooks et al., 89% of surveyed Black orthopaedic surgeons experienced some form

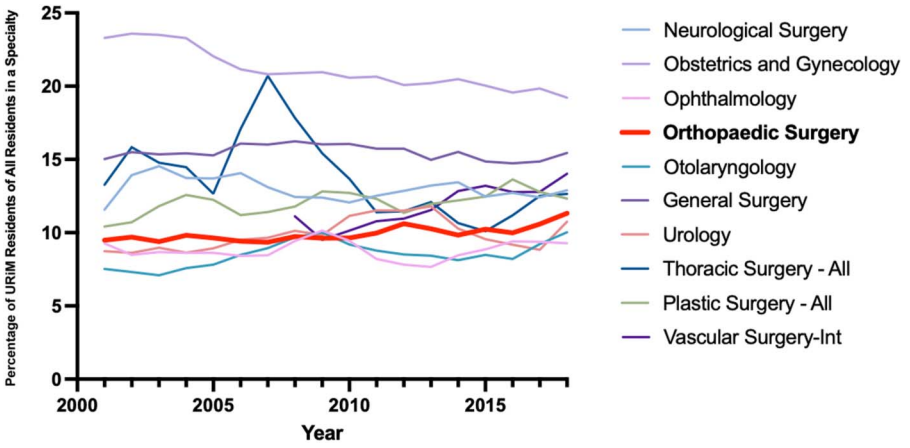

Fig. 3

Average percentage of URiM residents in orthopaedic surgery vs. other surgical specialties, 2001 to 2018. A breakdown over time of URiM trainees in various surgical subspecialty training programs; overall, there has been a general, but slow, increase in representation. URiM = under-represented in medicine.

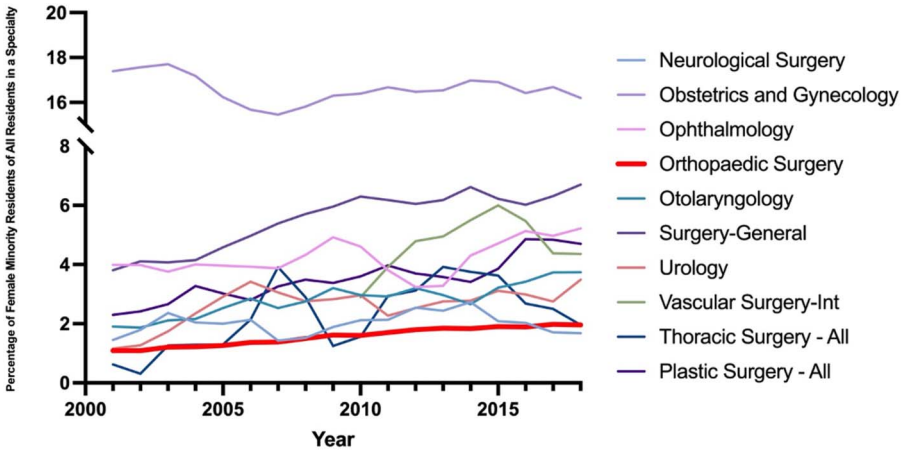

Fig. 4

Average percentage of female URiM residents in orthopaedic surgery vs. other surgical specialties, 2001 to 2018. This figure illustrates the general trend of slowly increasing URiM female representation; however, orthopaedics remains among the lowest of all surgical subspecialties. URiM = under-represented in medicine.

of racial microaggression in the workplace, with higher rates reported by Black female surgeons[24].

Previous studies examining the academic qualities of residents who successfully matched into orthopaedic programs found similar characteristics between men and women and determined that minority applicants are competitive based on conventional metrics[25,26]. Furthermore, a separate study evaluating the likelihood of admission based on race/ethnicity, sex, and academic performance found that race, but not sex, was independently associated with a lower odds of admission into orthopaedic residency when controlling for academic metrics[27]. Given the similarities of academic achievement among all applicants, it is unlikely that academic performance alone can explain the difference in attrition rates. Other reasons such as obligations outside of training, feelings of exclusion, or any of the myriad reasons that may result in involuntary withdrawal from a profession should be explored. These differences in attrition are very likely the product of a complex combination of any of the abovementioned reasons and warrant a more detailed in-depth investigation.

Bongiovanni et al. described 4 common themes correlated with attrition, including (1) clinical duties prioritized over education, (2) no safe area to share personal/programmatic concerns, (3) lack of role models, and (4) negative interactions with the authority[28]. Although factors, such as the location of the program, are static, others are intrinsic to the overall program or institution

TABLE I Resident Attrition and Dismissal Rates in Orthopaedic Surgery from 2001 to 2018

	Total No. of Residents (% of Total)	% Change 2001-2018	All Attrition (% of Total)	Unintended Attrition (% of Total)
Female	1,963 (12.9)	+77.19	117 (5.96)	41 (2.09)
Male	13,251 (87.1)	−7.42	370 (2.79)	134 (1.01)
Race/ethnicity				
Asian	1,979 (13)	+0.54	68 (3.44)	27 (1.36)
Black/African American	616 (4)	−8.70	59 (9.58)	35 (5.68)
Hispanic	384 (2.5)	−22.60	11 (2.86)	5 (1.30)
American Indian/Alaskan Native	53 (0.3)	−86.30	4 (7.55)	2 (3.77)
Multiracial/multiethnicity*	653 (4.3)	+4,676.92	28 (4.29)	7 (1.07)
Pacific Islander	17 (0.1)	−75.00	0 (0.00)	0 (0.00)
White	11,333 (74.5)	−6.93	307 (2.71)	94 (0.83)
Other/Unknown	180 (1.2)	+5,233.33	10 (5.56)	5 (2.78)
Under-represented in medicine	1,543 (10.1)	+19.28	95 (6.16)	48 (3.11)
Total	15,215		487 (3.20)	175 (1.15)

*Multiracial/multiethnicity includes residents identifying with 2 or more races/ethnicities.

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TABLE II Sex and URiM Demographic Composition and Relative Risk (RR) of Attrition in Orthopaedic Surgery (2001-2018)

	All Attrition RR (95% CI), p	Unintended Attrition RR (95% CI), p	% of All Residents	% of Total Attrition Composition
Asian	1.28 (0.98-1.67), p = 0.72	1.65(1.08-2.54)*	13.01	13.96
Black/African American	3.80 (2.84-5.09)***	7.20 (4.84-10.71)***	4.05	12.11
Hispanic	1.06 (0.57-1.95), p = 0.85	1.58 (0.64-3.90), p = 0.32	2.52	2.26
American Indian/Native American	2.93 (1.05-8.18)*	4.67 (1.12-19.54)*	0.35	0.82
Multiracial/multiethnicity	1.61 (1.08-2.39)*	1.30 (0.60-2.80), p = 0.51	4.29	5.75
Pacific Islander	N/A	N/A	0.11	0.00
URiM	2.36 (1.86-2.99)***	3.84 (2.70-5.46)***	10.14	19.51
Asian female	0.92 (0.50-1.68), p = 0.79	0.87 (0.30-2.53), p = 0.80	1.69	2.67
Black/African American female	3.64 (2.02-6.53)***	6.74 (3.13-14.51)***	0.60	3.29
Hispanic female	0.65 (0.16-2.72), p = 0.56	1.02(0.14-7.70), p = 0.98	0.36	0.41
Native American/American Indian female	4.32 (0.90-20.68), p = 0.07	N/A	0.07	0.41
Multiracial/multiethnicity female	0.74 (0.29-1.86), p = 0.52	0.46(0.06-3.40), p = 0.44	0.80	1.03
Pacific Islander female	N/A	N/A	0.00	0
All female	2.20 (1.78-2.73)***	2.09 (1.47-2.97)***	12.90	24.02
Asian male	1.39 (1.03-1.88)*	1.93 (1.20-3.11)**	11.32	11.29
Black/African American male	3.77 (2.69-5.29)***	7.16 (4.49-11.41)***	3.44	8.83
Hispanic male	1.19 (0.60-2.33), p = 0.62	1.76 (0.64-4.85), p = 0.28	2.16	1.85
Native American/American Indian male	2.06 (0.49-8.55), p = 0.32	6.97 (1.65-29.38)**	0.28	0.41
Multiracial/ethnicity male	1.91(1.23-2.96)**	1.63 (0.71-3.78), p = 0.25	3.49	4.72
Pacific Islander male	N/A	N/A		
All male	0.45 (0.37-0.56)***	0.48 (0.34-0.68)***	87.09	75.98

*p < 0.05, **p < 0.01, ***p < 0.001; N/A = not available because of zero attrition, and URiM = under-represented in medicine.

culture, including inability to express concerns, professional isolation, and an absence of role models or mentorship. These are modifiable aspects that residency programs should critically evaluate and intervene or improve upon to foster a more supportive training environment.

Limitations of this study include the large data set that is partially self-reported and census-based. A specific longitudinal cohort of individuals (person-based across time) was not achievable with this data set. For example, a resident may have already completed unknown years of residency at the conclusion of the study period while another resident may be just starting training. This makes it difficult to determine rates of attrition by year of training or a true trend over time, particularly at the tail ends of our data period. There is potential for variation in training lengths as well, with some residents completing general surgery or preliminary year or research years while other residents completed 5 years of orthopaedic residency without interruption. In addition, as previously noted, not all programs participated in GME Track reporting (estimated 80%-95% of all surgical training programs) and thus are not represented here.

Another limitation is the race/ethnic category allocation of residents because the survey responses for race and ethnicity changed during the study period. A resident with more than one race/ethnicity was categorized as multiracial for this study. This allocation may decrease the relative number of individual URiM group percentages. However, the authors believe that the use of the term "multiracial/multiethnicity" is more reflective of the individual rather than assigning a single "most-representative" race.

Finally, the reason for attrition was not explicitly indicated in the data set provided to protect the identities of both the individual and the program. Although we were able to look at rates of attrition, we were unable to identify specific reasons for attrition other than what were categorized in the survey, which were limited only to both voluntary attrition and involuntary attrition without underlying detail. Similarly, without granular attrition data, subgroups such as military obligations or VISA issues may be difficult to categorize as either voluntary or unintended attrition. Because of the nature of attrition data, and their incomplete ability to capture specific reasons for departure, assumptions or conclusions about the clinical, professional, or academic performance of residents should not be made.

As our specialty continues intensive efforts to recruit a more diverse and representative resident population, it is imperative that we similarly focus on initiatives to improve faculty and leadership diversity while also working to both retain and support residents in training during such an emotionally, physically, and

academically challenging time. Understanding and creating intentional intervention for these 3 pillars—recruitment, retention, and promotion—are critical.

Although it may take more time to substantially change the demographics of orthopaedic residencies, educational programs aimed at increasing awareness of unconscious bias, bystander training, and ensuring appropriate support and mentorship for female and URiM residents should be implemented to create a more inclusive culture. Not every URiM or female orthopaedic resident will have a mentor who shares a similar background, but an empathetic mentor can provide a safe place to share challenges and fears, discuss pathways to success, and be an advocate in improving a resident's training experience. Ultimately, elevating individuals to leadership positions who value mentorship and creating an inclusive and representative institutional culture can have a dramatic effect on both recruitment and retention.

Programs such as Nth Dimensions, the Ruth Jackson Orthopaedic Society, the J. Robert Gladden Society, and the Perry Initiative have made tremendous efforts to improve recruitment of female residents and minorities into orthopaedic surgery training programs; however, these resident groups face an increased risk of attrition over the years of training. A multifaceted approach focused on active mentorship, academic support, mental health awareness, and promotion of a diverse faculty is critical for successful retention of a diverse resident cohort. Without such growth, the specialty will continue to be unrepresentative of the patients we serve.

Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSOA/A525). This content was not copyedited or verified by JBJS. ■

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