



## AOA Critical Issues in Education

# What Program Characteristics Are Associated with Resident Racial Diversity in Orthopaedic Surgery? An Analysis of Association of American Medical Colleges Data

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**Background:** In orthopaedic surgery, there are fewer Black or African American (4%) and Hispanic or Latino (4%) residents compared with general surgery, internal medicine, family medicine, and pediatrics (5%-7% Black residents and 7%-9% Hispanic/Latino residents, respectively). There are also fewer underrepresented in medicine minority (URiM) faculty in orthopaedic surgery (6.1%) compared with general surgery (8.9%), otolaryngology (7.8%), internal medicine (9.7%), and obstetrics and gynecology (15.6%). Identifying program characteristics that are associated with the percentage of URiM residents could reveal strategies for improving diversity.

**Methods:** Using Association of American Medical Colleges orthopaedic resident and faculty race/ethnicity data from 2007 to 2016, we analyzed the racial diversity of 166 of 207 residency programs. The primary outcome was program racial diversity, measured as the percentage of URiM residents per program. The top quartile of programs was compared with the other quartiles. Characteristics analyzed included percentage of URiM faculty, affiliation with a university/top 40 medical school/top 40 orthopaedic hospital, geographic region, city type, and city size. We used a multivariable linear regression model to evaluate program characteristics associated with diversity and a linear mixed-effects model with program-specific random effects to evaluate time trends.

**Results:** The mean percentage of URiM residents per program was 9.3% (SD = 10.5%). In the top quartile of programs, URiM residents composed  $20.7\% \pm 2.5\%$  of the program compared with  $5.8\% \pm 0.3\%$  in other quartiles ( $p < 0.001$ ). After adjusting for program and faculty size, the only factor associated with the number of URiM residents per program was the number of URiM faculty. For every 5 additional URiM faculty members, there was an associated increase in the number of URiM residents per

*continued*

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program by 3.6 (95% confidence interval [CI]: 2.3-5.0). There was a small but statistically significant annual increase in the percentage of URiM residents per program of 0.207 (95% CI: 0.112-0.302) percentage points during the study period.

**Conclusion:** URiM representation remains low among orthopaedic residents. Efforts to increase the URiM faculty base represent a potential strategy for programs to increase URiM representation among residents by attracting more diverse applicants.

## Introduction

The association between physician-patient concordance with respect to race/ethnicity and (1) improved physician-patient trust<sup>1</sup>, (2) quality of and access to care<sup>2-4</sup>, and (3) patient satisfaction<sup>5</sup> is well established<sup>6-8</sup>. Because of the patient care benefits of increased physician diversity, there has been much recent interest within medicine to improve the diversity of the resident pool<sup>9</sup>. Creating greater diversity, equity, and inclusion in the future physician workforce is postulated to promote access and deliver better care for a diverse population<sup>10</sup>. The Institute of Medicine has long recognized the disparities in morbidity and mortality based on patient race, which might be effectively addressed with a more racially diverse physician workforce<sup>11</sup>. Although the need for a racially diverse resident base has been a critical healthcare issue<sup>12</sup>, the Accreditation Council for Graduate Medical Education (ACGME) implemented a workforce diversity provision in its Common Program Requirements in 2019<sup>13</sup>, leading to renewed interest in diversity, equity, and inclusion among resident physicians. Consequently, the lack of racial minority and female representation in orthopaedic surgery compared with other specialties (e.g., general surgery, otolaryngology, internal medicine, and pediatrics) has received much attention over the past decade<sup>6-8</sup>. Improving the gender and racial diversity of orthopaedic residents is a stated strategic goal of the American Academy of Orthopaedic Surgeons (AAOS). As such, the AAOS has created a diversity dashboard for tracking progress<sup>14,15</sup>.

Efforts to increase gender diversity have focused on increasing the availability of female faculty and resident mentors<sup>16-18</sup>. There is evidence to support a positive correlation between the numbers of female faculty and female residents<sup>19</sup>. Similarly, Okike et al. reported that higher faculty and resident gender diversity was associated with increased female applicants for an orthopaedic residency<sup>19-21</sup>. Between 2006 and 2015, Poon et al. reported that female representation in orthopaedic residents increased by 4 percentage points<sup>22</sup>. Similarly, Shah et al. reported an increase of 8.8 percentage points in female orthopaedic faculty between 1997 and 2017<sup>23</sup>. Unique challenges are faced by orthopaedic surgeons who identify as both female and URiM. According to the 2018 AAOS Census, Black female and Hispanic/Latino female orthopaedic surgeons each make up only 0.2% of total orthopaedic surgeons in the United States<sup>24</sup>. In one study of 455 Black orthopaedic surgeons, Black female respondents consistently reported lower occupational opportunity and greater discrimination than Black male surgeons<sup>25</sup>.

By contrast, the trend in racial diversity has not seen the same level of improvement. Between 2006 and 2015, White

representation in orthopaedic residents increased, despite an increase in the number of URiM medical students over the same period<sup>22</sup>. Multiple studies have shown that orthopaedic surgery remains one of the least diverse specialties<sup>8,23,26</sup>. The percentage of URiM orthopaedic residents declined from 9.3% in 2002 to 4.3% in 2011 before climbing slightly to 5.9% in 2016<sup>27</sup>. Shah et al. reported that URiM orthopaedic faculty increased by just 1.98 percentage points between 1997 and 2017; orthopaedic surgery had the lowest percentage of URiM faculty across all 18 specialties studied<sup>23</sup>. A hypothesized cause of this disparity is that URiM medical students may believe that few orthopaedic residency programs are suitable for them because most programs have low resident and faculty URiM representation. This belief may be rooted in structural factors, including bias in recruitment<sup>28,29</sup>, lack of opportunity<sup>18</sup>, lack of exposure to orthopaedic surgery or mentors<sup>17,30-32</sup>, and specialty reputation<sup>33</sup>. In addition, although there is a lack of data in disparities in attrition rate for orthopaedic residents<sup>28</sup>, racial/ethnic discrimination is linked with thoughts of attrition in general surgery residents<sup>34</sup>. Therefore, understanding factors associated with increased URiM representation among orthopaedic residency programs may play a crucial role in increasing racial diversity in orthopaedic surgery.

In this study, we aimed to answer the following questions: (1) What is the average URiM resident representation across orthopaedic residency programs? (2) What program factors are associated with higher URiM orthopaedic resident representation? (3) How has URiM orthopaedic resident representation changed over time?

## Methods

### Data Source and Variables

We obtained deidentified data from the Association of American Medical Colleges (AAMC) on 166 of 207 unique orthopaedic residency programs accredited by the ACGME on resident race from 2007 to 2016. The resident data are limited to residents who are citizens or permanent residents of the United States. Race categories consisted of American Indian or Alaska native, Asian, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander, White, other, or unknown. We additionally obtained deidentified AAMC data on full-time orthopaedic faculty race by affiliated medical school. Given the low numbers of racially diverse faculty, the AAMC reported faculty race as Asian only, White only, non-Asian/non-White, and other/unknown. The non-Asian/non-White category represented a combined group

of American Indian or Alaska native, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander races, White and another race, and Asian and another race. Residency program characteristics were determined, including residency program size, faculty size, affiliation with a university, a top 40 National Institutes of Health (NIH)-funded medical school (2017 data), or top 40 orthopaedic hospital in the US News and World Report ranking (2017 data); geographic region (Midwest, Northeast, Southeast, Southwest, West); and location (city type and size).

Residents were considered URiM if their stated race was American Indian or Alaska native, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander, alone or in combination with another race/ethnicity. These categories were chosen based on the AAMC guidance for defining URiM, which included any race with a lower representation in medicine than in the general US population (using 2016 US Census data)<sup>35,36</sup>. Given the manner in which the faculty race data were provided, URiM for that group was defined as non-Asian/non-White. For the analyses, we created a program-specific average of the percentage of URiM residents and affiliated medical school orthopaedic faculty across the 10-year study period for all program years available. Programs were then divided into quartiles based on their mean URiM resident percentage. Residency program characteristics and affiliated medical school orthopaedic faculty race diversity of the top quartile were then compared with the other quartiles.

### Statistical Analysis

Count data are reported as frequencies and percentages and analyzed using chi-square tests. Continuous data are reported as mean and standard error (unless otherwise specified) and analyzed using the Wilcoxon rank sum test. We created a multivariable linear regression model to evaluate the association between the number of URiM residents per program and the above residency program characteristics. To determine time trends, we created a linear mixed-effects regression model with program-specific random intercepts. Within the mixed-effects model, program characteristics such as affiliation with a university, top 40 medical school, top 40 orthopaedic hospital, geographic region, city type, and city size were entered as fixed effects. Statistical significance was defined as  $p < 0.05$ .

### Source of Funding

There are no funding sources for this investigation.

## Results

### Program Characteristics and Comparisons

Data were obtained from the AAMC for all orthopaedic residency programs ( $n = 166$ ) and affiliated medical school orthopaedic faculty ( $n = 113$ ) with available race information between 2007 and 2016 (Table I). The mean percentage of URiM residents per program over the 10-year study period was 9.3% with a SD of 10.5%. The racial composition of all 166 programs

and all affiliated medical school orthopaedic faculty by White, Asian, or URiM status is shown (Fig. 1). Of 166 programs, 141 (85%) had less than 15% URiM resident representation. By contrast, 165 of the 166 programs (99%) consisted of greater than 41% White residents. Most of the programs were affiliated with universities (132/166, 80%). Programs were located in the Midwest (40/166, 24%), Northeast (51/166, 31%), Southeast (37/166, 22%), Southwest (18/166, 11%), and West (20/166, 12%).

Programs were separated into quartiles by mean percentage of URiM residents (Fig. 2). The top quartile of programs had a mean of  $20.7\% \pm 2.5\%$  URiM residents compared with  $5.8\% \pm 0.3\%$  URiM residents in the bottom 3 quartiles ( $p < 0.001$ , Table I). Affiliated medical school orthopaedic faculty race data were available for 29 of the 42 programs (69%) in the top quartile and 99 of the 125 programs (79%) in the other quartiles. Overall, there was a mean URiM faculty composition of 7.5% with a SD of 12.0%. For the top quartile of programs, the mean URiM orthopaedic faculty composition at the affiliated medical school was  $13.8\% \pm 4.2\%$  compared with  $5.7\% \pm 0.5\%$  for programs in the other quartiles ( $p = 0.047$ , Table I). There were no differences between the top and other quartiles regarding other program characteristics (affiliated with a university, top 40 medical school, or top 40 orthopaedic hospital), geographic region, or city type or size (Table I).

### Factors Associated with URiM Resident Composition

We then analyzed program characteristics associated with the number of URiM residents per program using a linear regression model. After adjusting for program and faculty size, only the number of URiM orthopaedic faculty at the affiliated medical school was associated with the number of URiM residents per residency program ( $p < 0.001$ , Table II). For every 5 additional URiM faculty members, the number of URiM residents per program increased by 3.6 (95% confidence interval [CI]: 2.3-5.0). Affiliation with a university, top 40 medical school, or top 40 orthopaedic hospital; geographic region; city type; and city size were not associated with any difference in the number of URiM residents per program.

### Time Trends

Over the study period, the mean percentage of URiM residents per program increased from 8.9% (SD = 11.1%) in 2007 to 10.4% (SD = 12.3%) in 2016 (Fig. 3). Using a linear mixed-effects model with random intercepts to evaluate changes in URiM resident representation, we found a small but statistically significant annual increase in the percentage of URiM residents per program of +0.207 (95% CI: 0.112-0.302;  $p < 0.001$ ) percentage points per year (Table III).

## Discussion

In most (141/166, 85%) of the ACGME-accredited orthopaedic residency programs studied, less than 15% of residents belonged to a URiM racial group. After controlling for program and faculty size, the only factor out of the

TABLE I Program Demographic Data

Variable	Top Quartile	Other Quartiles	p-value
No. of programs, n	42	124	
Top 40 medical school, n (%)			0.50
Yes	8 (19.0)	32 (25.8)	
No	34 (81.0)	92 (74.2)	
Top 40 orthopaedic hospital, n (%)			0.76
Yes	9 (21.4)	22 (17.7)	
No	33 (78.6)	102 (82.3)	
University-affiliated, n (%)			0.20
Yes	30 (71.4)	102 (82.3)	
No	12 (28.6)	22 (17.7)	
Region, n (%)			0.31
Midwest	5 (11.9)	35 (28.2)	
Northeast	15 (35.7)	36 (29.0)	
Southeast	10 (23.8)	27 (21.8)	
Southwest	6 (14.3)	12 (9.7)	
West	6 (14.3)	14 (11.3)	
City type, n (%)			0.13
Rural	4 (9.5)	12 (9.7)	
Suburban	5 (11.9)	29 (23.4)	
Urban	33 (78.6)	83 (66.9)	
City size, n (%)			0.23
<100,000	7 (16.7)	25 (20.2)	
100,000-500,000	14 (33.3)	23 (18.5)	
500,000-1,000,000	12 (28.6)	49 (39.5)	
>1,000,000	9 (21.4)	27 (21.8)	
URiM residents, mean % (SE)	20.7 (2.5)	5.8 (0.3)	<0.001
URiM faculty,* mean % (SE)	13.8 (4.2)	5.7 (0.5)	0.047

\*Faculty data were available for 124 programs. SE = standard error.

limited set studied associated with an increased number of URiM residents was a higher number of URiM orthopaedic faculty at the affiliated medical school. There was a small but statistically significant annual increase in the percentage of URiM residents per program between 2007 and 2016.

### Program Characteristics and Comparisons

Our results align with previous data showing that URiM representation in orthopaedic residents trails other subspecialties<sup>8,27</sup>. One study characterized African American and Hispanic representation among orthopaedic residents from 1968 to 2008, finding that representation of these groups increased at a rate of 0.55% and 1.37% per decade, respectively<sup>26</sup>. These were considerably lower than the rates of growth seen for the same groups among college and medical students, suggesting that URiM applicants may be filtered out at the residency application and/or selection stage. A

recent study showed that URiM status is associated with a lower odds of admission into orthopaedic residency after accounting for academic performance<sup>29</sup>. Strategies for eliminating this racial disparity could include increasing the diversity of residency selection committees, blinding of applications, bias training, and holistic review<sup>29</sup>. Another study found a decline in the representation of URiM groups between medical school and orthopaedic residency; these groups also submitted fewer residency applications compared with their White or Asian peers<sup>8</sup>. Our study contributes to this literature by suggesting potential ways to increase URiM resident representation. We demonstrated that most of the program characteristics studied, especially nonmodifiable ones (university affiliation, location, and city type and size) and those that are challenging to modify (top 40 medical school or orthopaedic hospital) are not associated with greater URiM representation. Because the only factor studied that was associated with increased URiM resident representation was affiliated medical

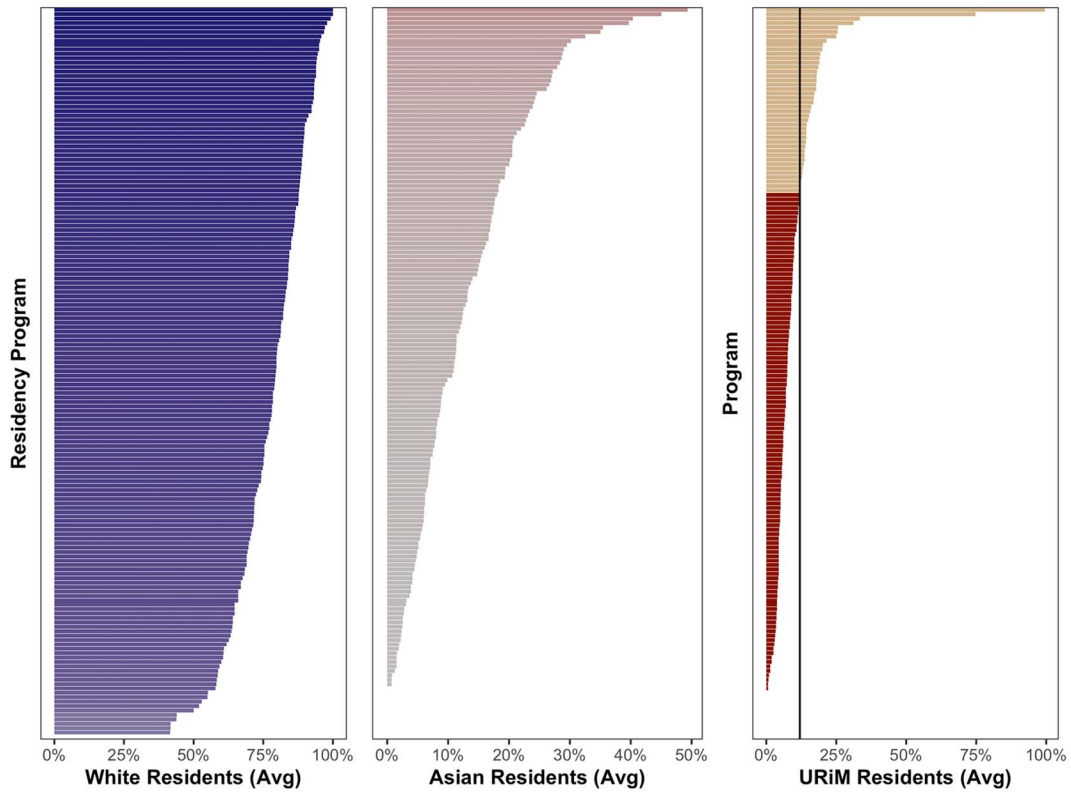


Fig. 1-A

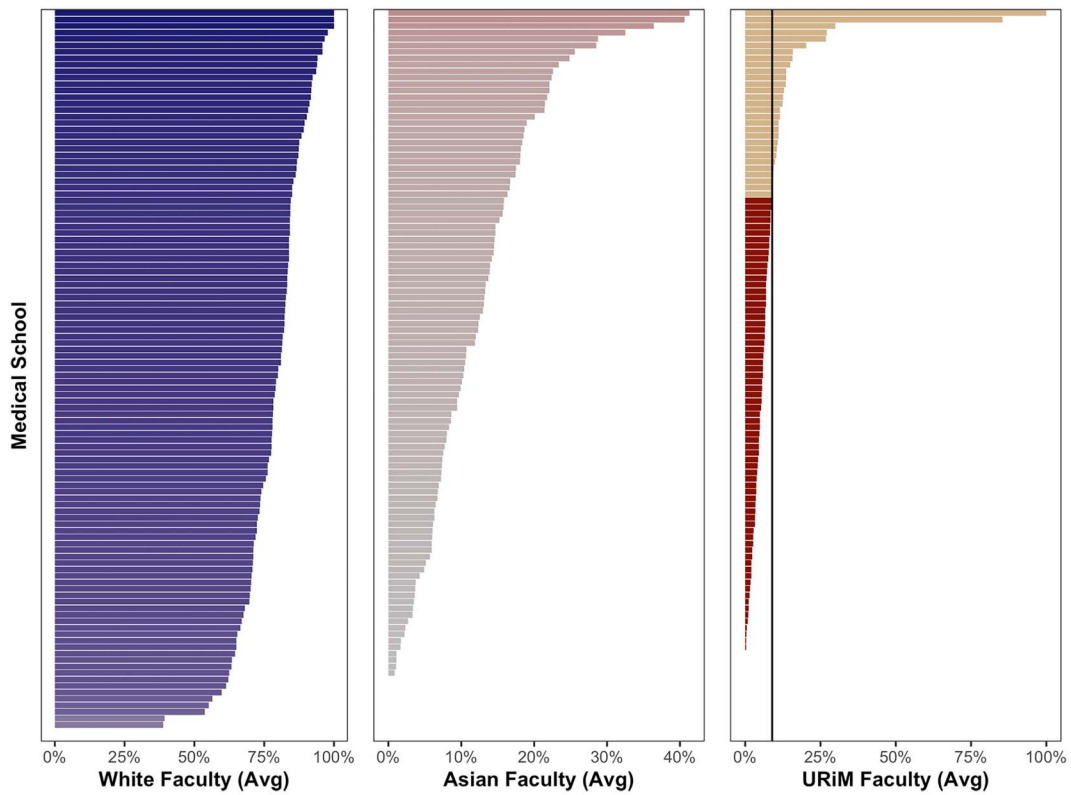


Fig. 1-B

**Fig. 1** Racial comparison of orthopaedic residency program (**Fig. 1-A**) residents and (**Fig. 1-B**) affiliated medical school faculty.

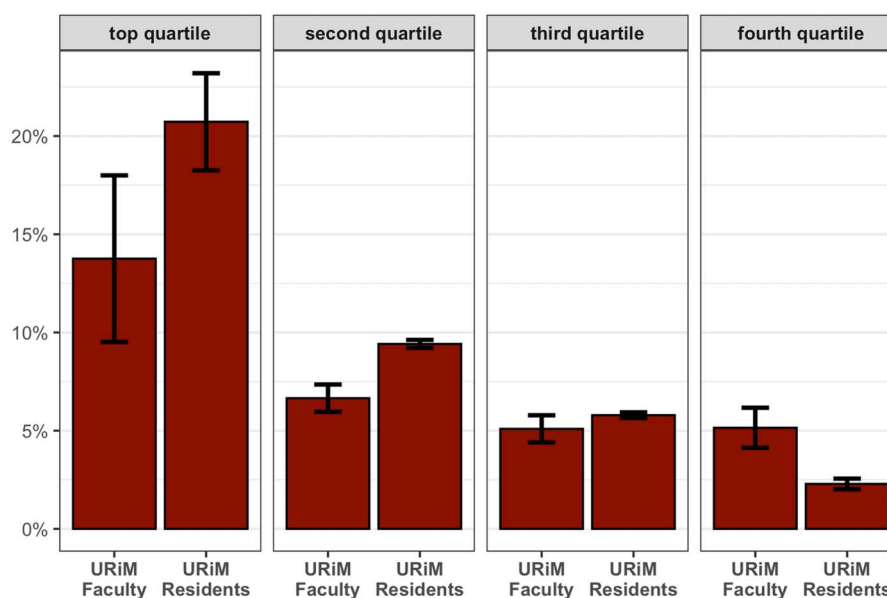


Fig. 2  
Mean percentage of URiM residents and faculty by program quartile. Error bars denote the standard error of the mean.

TABLE II Factors Associated with Number of URiM Residents Within Each Program*			
Variable	Coefficient (95% CI)	p-value	
Program characteristics			
Mean no. of residents	0.128 (0.076 to 0.179)	<0.001	
Top 40 medical school	-0.775 (-1.819 to 0.268)	0.14	
Top 40 orthopaedic hospital	0.495 (-0.834 to 1.823)	0.46	
University-affiliated	0.053 (-1.645 to 1.751)	0.95	
Location			
Region			
Midwest	Reference		
Northeast	0.570 (-0.579 to 1.720)	0.33	
Southeast	0.271 (-0.897 to 1.440)	0.65	
Southwest	0.208 (-1.424 to 1.839)	0.80	
West	0.891 (-0.606 to 2.388)	0.24	
City type			
Rural	Reference		
Suburban	-0.228 (-1.829 to 1.373)	0.78	
Urban	0.613 (-0.797 to 2.023)	0.39	
City size			
100,000 or less	Reference		
100,001-499,999	-0.044 (-1.285 to 1.197)	0.95	
500,000-999,999	-0.068 (-1.499 to 1.362)	0.93	
1,000,000 or greater	0.043 (-1.417 to 1.503)	0.95	
Faculty characteristics			
Mean no. of faculty	-0.064 (-0.091 to -0.037)	<0.001	
URiM faculty	0.727 (0.456 to 0.998)	<0.001	

\*CI = confidence interval.

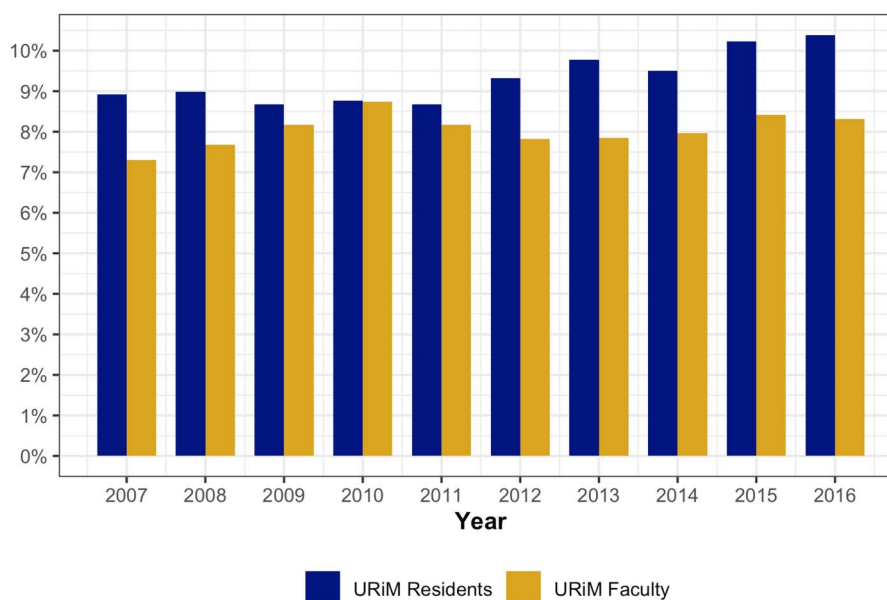


Fig. 3  
Trend in mean percentage of URiM residents and faculty per program over time.

TABLE III Linear Mixed-Effects Model Evaluating Program URiM Resident Composition Over Time*		
Variable	Coefficient (95% CI)	p-value
Year	0.207 (0.112 to 0.302)	<0.001
Program characteristics		
Top 40 medical school	-2.876 (-7.542 to 1.792)	0.25
Top 40 orthopaedic hospital	1.695 (-3.259 to 6.654)	0.52
University-affiliated	0.223 (-4.030 to 4.482)	0.92
Location		
Region		
Midwest	Reference	
Northeast	3.303 (-1.343 to 7.947)	0.18
Southeast	4.888 (0.206 to 9.566)	<0.05
Southwest	3.935 (-2.396 to 10.253)	0.24
West	2.346 (-3.537 to 8.215)	0.45
City type		
Rural		
Rural	Reference	
Suburban	-2.754 (-8.982 to 3.475)	0.40
Urban	1.366 (-4.595 to 7.323)	0.67
City size		
100,000 or less		
100,000 or less	Reference	
100,001-499,999	0.177 (-4.838 to 5.198)	0.95
500,000-999,999	-0.166 (-6.206 to 5.878)	0.96
1,000,000 or greater	1.653 (-4.419 to 7.725)	0.61

\*CI = confidence interval.

school URiM orthopaedic faculty, concerted efforts to increase URiM faculty members through focused recruitment and mentorship may help increase URiM resident representation.

#### *Factors Associated with URiM Resident Representation*

Despite several calls to action for the recruitment of racially diverse residents, progress has been slow. A recent study by Poon et al. showed a decrease in URiM residents and an increase in White residents from 66.7% to 77.5% from 2006 to 2015<sup>22</sup>. For comparison, the percentage of women in orthopaedic programs increased from 10.9% to 14.4% over the same period<sup>22</sup>. Potential explanations for this discrepancy include a lack of URiM applicants, lack of URiM resident/faculty mentors, or both. Although previous studies have shown the promise of “push” strategies such as expanding the reach of summer orthopaedic internship programs and a stronger orthopaedic clinical curriculum for medical students<sup>18,33</sup>, our study suggests a potential “pull” strategy. By recruiting URiM faculty, institutions may be able to “pull” in a more racially diverse applicant base, which may convert into a more diverse resident pool. This theory is supported by Okike et al., who reported that URiM medical students at schools with high URiM orthopaedic faculty and resident representation were more likely to apply for an orthopaedic surgery residency<sup>37</sup>.

#### *Time Trends*

Our data show a small, but statistically significant, annual increase in URiM residents per program over the study period. Although Poon et al. showed a decrease in URiM orthopaedic resident representation from 2006 to 2015 using a different data set, the authors used a different definition of URiM that included Asians, making comparison with our study difficult<sup>22</sup>. We did not include Asians in our definition of URiM because they do not have lower representation in orthopaedic surgery than in the general population<sup>23</sup>. In addition, the Poon et al. study only included residents entering orthopaedic training, rather than all active residents, with race/ethnicity data stemming exclusively from the Electronic Residency Application Service. For this study, the race/ethnicity data stem from multiple AAMC applications an individual had with the AAMC. Although initiatives such as increasing the availability of orthopaedic clinical experiences have shown promise<sup>18,33</sup>, additional research is needed to reveal more effective strategies for increasing and sustaining racial diversity in resident and faculty recruitment and advancement.

#### *Limitations*

This study has several limitations. First, our results demonstrate a correlation between the number of URiM residents and URiM faculty, not a causal pathway. In other words, URiM residents may later be drawn back as faculty members to the same institution because of unobserved factors that attracted them in the first place. The data set used in this study relies on accurate reporting of resident and faculty race data to the AAMC. Owing to the

restricted granularity of faculty race data, a small number of faculty who identified as both White and Asian may have been included in the non-White/non-Asian category. Because our data only contain observations between 2007 and 2016, our results may not be generalizable beyond this time frame, especially as the outcomes of strategic diversity initiatives become apparent. Our data contained a nonexhaustive set of program characteristics that were used to compare programs, and thus, we cannot exclude the possibility that other unobserved influential factors exist. For example, although strong diversity and inclusion recruitment efforts, medical student outreach programs, and formal URiM mentorship programs are likely influential on orthopaedic resident racial/ethnic composition<sup>18,30,33,38,39</sup>, we were unable to evaluate their effect in this study. In addition, because NIH funding and orthopaedic hospital ranking data from 2017 were used, we were unable to account for year-to-year variation in these rankings. Finally, several military programs were included in this analysis, which may differ from civilian programs. However, owing to their small number, it is unlikely that they drove the statistical findings.

#### *Conclusion*

In conclusion, this study of AAMC data on orthopaedic resident race from 2007 to 2016 found that URiM orthopaedic resident representation remains low, with an average of 9.3% per program, despite recent efforts by the AAOS and other organizations to improve resident recruitment. After adjusting for multiple program factors, the only factor associated with the number of URiM residents was the number of URiM orthopaedic faculty at the affiliated medical school. This suggests that a potential strategy for attracting URiM residents is to improve URiM faculty recruitment, retention, and promotion. ■

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