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Effect of Faculty Diversity on Minority Student Populations Matching into Orthopaedic Surgery Residency Programs

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Background: Greater faculty diversity within orthopaedic residency programs has been associated with an increased application rate from students of similarly diverse demographic backgrounds. It is unknown whether these underrepresented student populations have an equitable likelihood of being highly ranked and matching at these programs. Thus, we sought to evaluate the relationship between faculty and resident diversity, with a specific focus on sex, racial/ethnic groups that are underrepresented in medicine (URiM), and international medical graduates (IMGs).

Methods: The American Orthopaedic Association's Orthopaedic Residency Information Network database was used to collect demographic data on 172 US residency programs. Linear regression analyses were performed to determine the relationship between the proportion of female or URiM attendings at a program and the proportion of female, URiM, or IMG residents or top-ranked applicants (≥ 25 rank). URiM was defined as "racial and ethnic populations that are underrepresented in the medical profession relative to their numbers in the general population."

Results: A mean of 13.55% of attendings were female and 14.14% were URiM. A larger fraction of female attendings was a positive predictor of female residents ($p < 0.001$). Similarly, a larger percentage of URiM attendings was a positive predictor of URiM residents ($p < 0.001$), as well as of URiM ($p < 0.001$) and IMG ($p < 0.01$) students being ranked highly. There was no significant association between URiM attendings and female residents/overall top-ranked applicants, or vice versa.

Conclusions: Residency programs with more female attendings were more likely to match female residents, and programs with more URiM attendings were more likely to highly rank URiM and IMG applicants as well as match URiM residents. Our findings indicate that orthopaedic surgery residencies may be more likely to rank and match female or URiM students at similar proportions to that of their faculty. This may reflect minority students preferentially applying to programs with more diverse faculty because they feel a better sense of fit and are likely to benefit from a stronger support system.

Level of Evidence: III.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJSOA/A449>).

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Introduction

Orthopaedic surgery has historically been one of the least diverse specialties in medicine and surgery¹. Among all surgical disciplines, orthopaedic surgery residency programs have had the lowest female representation according to the 2020 to 2021 Graduate Medical Education Census², as well as the least racial/ethnic diversity compared with all other residencies³. Similarly, other nontraditional student populations, such as international medical graduates (IMGs) and Doctors of Osteopathic Medicine (DOs) degree graduates, have matched into orthopaedic residencies at disproportionately low rates⁴.

Substantial efforts have been made to resolve these disparities, including the establishment of organizations such as the J. Robert Gladden Orthopaedic Society, Nth Dimensions, American Association of Latino Orthopaedic Surgeons, and Ruth Jackson Orthopedic Society, all of which aim to provide opportunities and mentorship to underrepresented students^{5,6}. Although the percentage of female and underrepresented in medicine (URiM) orthopaedic residents has risen over time, they continue to lag behind the growing demographic diversity of national medical student populations^{3,7}. According to the National Resident Matching Program's most recent 2022 Main Residency Match, DOs and IMGs only comprised 12.7% and 2.2% of matched applicants, respectively⁸.

Previous studies have suggested that the proportion of underrepresented applicants who ultimately match into an orthopaedic residency program is highly variable across institutions⁷. Okike et al. found that a more diverse faculty enhances the application rate of minority populations to a given program^{9,10}. However, it remains unclear whether these students are more or less likely to be highly ranked, and ultimately match, at programs with more diverse faculty. In this study, we analyzed the relationship between faculty and resident diversity to determine whether certain applicant populations are at an increased likelihood of being ranked highly by programs with diverse faculty. We hypothesized that programs with increased female and URiM attendings would be more likely to rank and hire minority applicants.

Materials and Methods

All data in this study were obtained directly from the American Orthopaedic Association's Orthopaedic Residency Information Network (ORIN)¹¹. The database includes de-identified residency program information sourced directly from program administrators and directors of all Council of Orthopaedic Residency Directors (CORD)-member orthopaedic surgery residency programs across the United States. Collection of data from the programs themselves helps to ensure that all information within the database is accurate. The CORD-member programs included in the database comprise 96% of all orthopaedic surgery residency programs. Because the ORIN database is openly available for public use, this study did not qualify as human subjects research and was therefore exempt from institutional review

board approval. There was also no source of funding for this study.

On July 20, 2022, the following data were extracted for each residency program in the ORIN database: proportion of female attendings, URiM attendings, female residents, URiM residents, and IMG residents. The proportion of women, URiMs, and IMGs among the top 25 ranked applicants at a given program in the most recent residency match was also recorded. URiM was defined as "racial and ethnic populations that are underrepresented in the medical profession relative to their numbers in the general population," according to the Association of American Medical Colleges¹². Programs lacking data on specific demographic groups were excluded from the relevant analyses.

All included variables were characterized using mean and SD because of all variables being continuous. Bivariate linear regression was performed to evaluate female or URiM faculty as a predictor of a program's resident demographics. The proportion of women, URiMs, and IMGs among the top 25 ranked applicants was also evaluated as a predictor of a program's resident demographics to determine whether programs that highly rank diverse applicants ultimately achieve a more diverse residency class. All statistical analysis was conducted by a trained biostatistician using IBM SPSS Statistics software (IBM, Version 27). A p value < 0.05 was set as the threshold for statistical significance.

Results

Included Programs

Program data from 172 orthopaedic residency programs was reported in the ORIN database and included in this analysis. The proportion of female and URiM faculty was reported by 142 and 130 programs, respectively. Women represented a mean of 13.55% of attendings and URiMs represented a mean of 14.14% of attendings. The proportion of female and URiM residents was reported by 154 and 143 programs, respectively. Women represented a mean of 18.82% of residents and URiMs represented a mean of 19.15% of residents. A complete list of the pooled attending and resident demographics can be found in Table I.

Faculty Sex Diversity

In total, 137 programs reported sex distributions for both attendings and residents at their institution. On linear regression, a greater percentage of female attendings was found to be a positive predictor of female residents ($\beta = 0.48$, $p < 0.001$) (Fig. 1). Female faculty representation did not have any other significant positive relationships with other resident or top-ranked applicant demographics (Table II).

Faculty Racial/Ethnic Diversity

In total, 120 programs reported the proportion of URiMs for both attendings and residents at their institution. For every percent increase in URiM attendings, the model predicted a +0.67% rise in the percent of URiM residents ($\beta = 0.67$, $p < 0.001$) (Fig. 2). Similarly, across 83 programs that also

TABLE I Pooled Demographics*		
	N	Mean (SD)
Attendings		
URiM	130	14.14% (14.44)
Female	142	13.55% (8.49)
Residents		
URiM	143	19.15% (14.13)
Female	154	18.82% (10.98)
IMG	125	1.71% (3.72)
Top 25 ranked applicants		
URiM	91	30.24% (20.04)
Female	98	34.81% (21.60)
IMG	68	2.06% (6.72)

*N = number of programs in which variable was reported. IMG = international medical graduates and URiM = underrepresented in medicine.

reported the number of URiM top-ranked applicants, there was a significant positive association between percent URiM attendings and percent of URiM top-ranked applicants ($\beta = 0.54$, $p < 0.001$). Top-ranked applicants were also more likely to be an IMG at programs with greater URiM faculty representation ($\beta = 0.15$, $p < 0.01$). No significant relationship was found between percent URiM attendings and percent of female residents, IMG residents, or percent of female top-ranked applicants (Table II).

Top 25 Ranked Applicant Diversity

For all resident demographics evaluated, programs that highly ranked a particular applicant population were associated with a greater proportion of the respective demographic among its residents. A program's residents were more likely to be women at programs where women constituted a greater proportion of top 25 ranked applicants ($\beta = 0.19$, $p < 0.001$). Similarly, residents were more likely to be URiMs or IMGs at programs where URiMs or IMGs, respectively, constituted a greater proportion of top 25 ranked applicants ($\beta = 0.29$, $p < 0.001$; $\beta = 0.34$, $p < 0.001$, respectively).

Discussion

To the best of our knowledge, this study is among the first to analyze orthopaedic residency data using the recently developed ORIN database. Using this information, we aimed to assess whether the diversity of a program's faculty was associated with the likelihood of that program ranking highly and/or matching traditionally underrepresented residency applicants. As expected, we found that women, URiMs, and IMGs constituted a disproportionately smaller percent of orthopaedic surgery residents and attendings. We additionally report that greater female or URiM representation among a program's faculty was positively associated with the odds of its residents also being women or URiMs, respectively. Programs with more URiM attendings were also more

likely to rank IMG students highly. Interestingly, however, programs with greater female faculty representation were not any more likely to match URiM applicants, and programs with greater URiM faculty representation were not any more likely to match female applicants.

The results of our study reflect the well-documented underrepresentation of women and URiMs in the field of orthopaedics^{2,3}. Although women and URiMs were a minority among both residents and attendings in our study, they constituted a larger proportion of residents compared with attendings which may indicate a slow trend toward greater representation. This is in line with recent longitudinal studies of diversity in orthopaedics; however, the proportion of minority populations in orthopaedics continues to lag far behind other specialties and national averages^{1,13}. Efforts to continuously improve diversity in orthopaedics are of major significance not only to create equity for residency applicants but also to improve the future of patient care in the field. URiM physicians are more likely to practice in underserved communities and treat minority patients and may be able to provide a more culturally competent care for such patients^{14,15}. As a result, these patients tend to report higher satisfaction and feel more involved in the decision-making of their care when there is racial concordance with their physician^{16,17}. In an effort to contribute to an increasingly diverse field, our study further evaluates the factors that influence greater minority representation in the next generation of orthopaedic surgeons.

When looking at the relationship between faculty and resident diversity, our findings show that female and URiM applicants have an increased likelihood of matching at

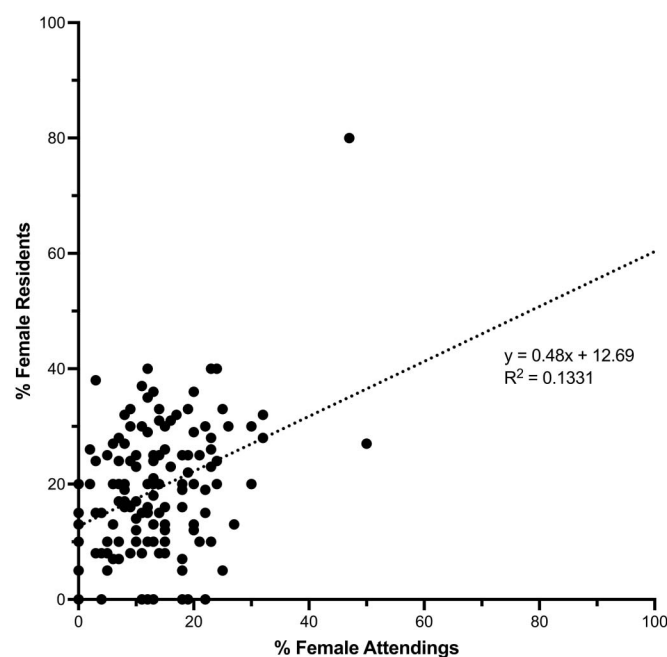


Fig. 1
Relationship between percentage of female attendings and percentage of female residents.

TABLE II Linear Regression Results*						
	% URiM Attendings			% Female Attendings		
	N	β	p-value	N	β	p-value
% URiM residents	120	0.67	<0.001	130	0.12	0.39
% Female residents	126	-0.12	0.12	137	0.48	<0.001
% IMG residents	105	0.02	0.44	113	0.06	0.16
% URiM ranked in top 25	83	0.54	<0.001	85	0.05	0.83
% Female ranked in top 25	90	0.13	0.40	92	0.22	0.35
% IMG ranked in top 25	62	0.15	<0.01	66	-0.09	0.35

*N = number of programs included in the regression model. IMG = international medical graduates and URiM = underrepresented in medicine. Bold = p-value < 0.05

programs with greater faculty sex and racial diversity, respectively. Jagsi et al. illustrated a similar finding in other medical specialties, whereby female students were more likely to match at residency programs with greater percentages of female residents, compared with their male counterparts¹⁸. This phenomenon may be explained by programs with more diverse faculty receiving a higher number of underrepresented applicants, thus increasing the odds of a matched applicant being a woman or URiM^{9,10}. In addition to applying at greater rates, minority applicants may also be inclined to rank these programs higher. Female and URiM students are more likely to value and seek role models of the same sex and/or ethnicity¹⁹, perhaps because faculty of relatable demographics help underrepresented students visualize

their ability to fit into the program²⁰. Therefore, program desirability from the applicant perspective coupled with the increased likelihood of being ranked highly by the program, as shown in our study, may explain the greater demographic diversity of residents at programs with commensurately diverse faculty.

Another possible explanation for the association between faculty and resident diversity could be that programs with more female and URiM attendings are more likely to directly target the recruitment of minority applicants. Our findings illustrated that programs that targeted minority applicants through highly ranking them ultimately saw an increase in the diversity of their residents. In their survey of 75 orthopaedic surgery residency programs, McDonald et al. found that 32% of programs attributed not specifically recruiting minority residents as a barrier to their program's diversity²¹. On the contrary, programs with a greater proportion of underrepresented faculty have shown to place greater emphasis on recruiting minorities by collaborating with outreach programs such as Nth Dimensions and The Perry Initiative²¹. Such efforts may contribute to the link between faculty and resident diversity because URiM Nth Dimensions scholars are significantly more likely to go on to pursue and match into orthopaedic surgery²². Thus, programs seeking to enhance their resident diversity should consider recruiting more highly ranking diverse applicants. Programs with greater URiM faculty representation were also more likely to have top 25 rank IMG applicants despite there being no significant relationship with matching of these IMG applicants. We believe this finding may be due to potentially overlapping applicant demographics, with many IMG applicants also being classified as URiMs²³.

This study is not without limitations. As a retrospective analysis, the findings herein only represent associations and do not imply causation. Furthermore, although the ORIN database provides a comprehensive source of residency program data, it does have some limitations that are important to note in the context of this study. First, the results of this study were based only on residency programs within the CORD association and were limited to the completeness and

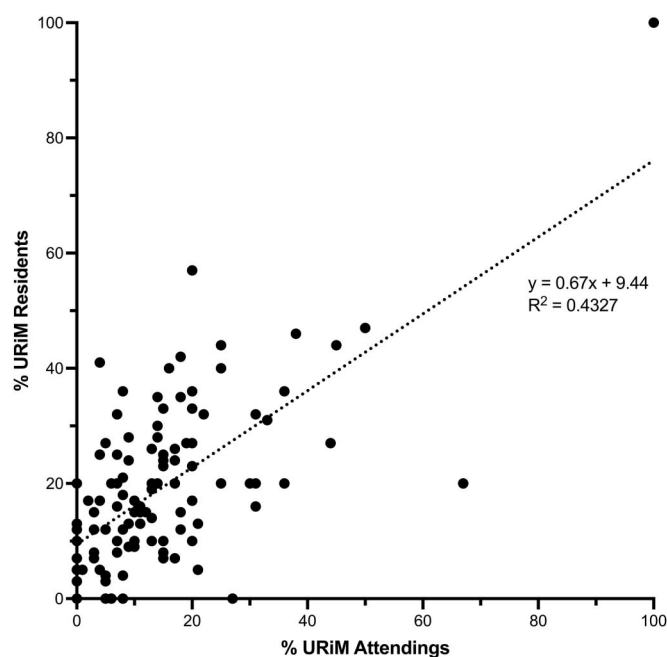


Fig. 2
Relationship between percentage of URiM attendings and percentage of URiM residents.

accuracy of data self-reported by each individual program. Although most programs reported resident and faculty diversity, many programs failed to report demographics of top-ranked applicants, possibly owing to programs' hesitancy to report low diversity or potentially deidentify ranked applicants. Furthermore, data were updated at the leisure of each program, which may have led to some program information being outdated. However, because of the database's recent development, all data were provided no earlier than 2021, with included CORD-member programs comprising 96% of orthopaedic surgery residency programs. Second, the database does not provide information on attendings degree or IMG status, which restricted our ability to assess for a relationship with matching of DO and IMG applicants. Third, the ORIN database does not provide more detail regarding the proportion of top-ranked applicants from a program's "home institution" nor the actual rank of ranked applicants, beyond whether they were in the top 25 of the program's rank list. Thus, it is unclear which applicants were actually ranked higher than others. Nevertheless, this data source offers a unique opportunity to investigate demographic and program-specific data provided directly from program administrators, such as rank list information and score requirements which may otherwise be difficult to crowdsource accurately. Future studies

should make use of this novel and robust database to better understand the orthopaedic residency application and match process. ■

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