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Demographic Factors and Medical School Experiences Associated with Students' Intention to Pursue Orthopaedic Surgery and Practice in Underserved Areas

Michele Cerasani, MD, Moje Omoruan, MD, Carolyn Rieber, BS, Mytien Nguyen, MS, Hyacinth R.C. Mason, MPH, PhD, Brian Clair, MD, MBA, Steven C. Stain, MD, Amadeus R. Mason, MD, and L Scott Levin, MD

Investigation performed at University of Pennsylvania, Philadelphia, PA

Introduction: Physician shortages across the United States will affect access to orthopaedic care for patients. Orthopaedic surgery is predicted to have one of the largest shortages among surgical subspecialties by 2025, which will disproportionally affect patients in medically underserved areas. This study examines characteristics and experiences of graduating medical students interested in orthopaedic surgery who intend to practice in underserved areas (IPUAs).

Methods: We analyzed deidentified data of AAMC Graduation Questionnaire respondents who matriculated between 2007 to 2008 and 2011 to 2012. Forty-eight thousand ninety-six (83.91%) had complete demographic, financial, and medical school elective data and were included in the study cohort. Multivariable logistic regression was performed to determine the correlation between student characteristics and intention to pursue orthopaedic surgery and IPUAs.

Results: Of the 48,096 students with complete information, 2,517 (5.2%) intended to pursue a career in orthopaedic surgery. Among the orthopaedic students, men were less likely than women to report IPUAs (adjusted odds ratio [aOR], 0.6; 95% CI, 0.4-0.8). Students who identified as Black/African American (aOR, 5.0; 95% CI, 3.0-8.2) or Hispanic (aOR, 2.0; 95% CI, 1.1-3.5) were more likely than White students to report IPUAs. Medical students who intend to pursue orthopaedics and received a scholarship (aOR, 1.5; 95% CI, 1.1-2.0), participated in community research (aOR, 1.8; 95% CI, 1.4-2.3), or had a global health experience (aOR, 1.9; 95% CI, 1.5-2.5) were more likely to report IPUAs.

Discussion: If orthopaedic surgeons who reported as medical students who reported IPUAs actually do so, recruiting and retaining more sex and race/ethnically diverse orthopaedic surgeons could reduce the impact of the impending shortage of orthopaedic surgeons in underserved areas. IPUA is correlated to medical school experiences related to cultural competency including global health experiences and community-based research projects.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSOA/A450).

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Introduction

Orthopaedic surgery is predicted to have one of the largest shortages among surgical subspecialties by 2025[1]. Physician shortages across the United States will affect access to orthopaedic care for all patients, especially those residing in medically underserved areas (MUAs). The maldistribution of healthcare providers across the United States has created MUAs, defined by the Health Resources and Services Administration (HRSA) as geographical regions with lack of access to medical care[2]. MUAs are geographical areas that can include a county, group of counties or civil divisions, and urban census tracts[2]. The HRSA projects that by 2025, orthopaedic surgery will sustain the second largest shortage among surgical subspecialties, with an expected deficit of 5,050 surgeons[1]. Therefore, equity of access to orthopaedic care is both limited by the number of orthopaedic surgeons and by the distribution of them. Without enough practicing orthopaedic surgeons, equity and access to high-quality orthopaedic care will become more challenging, and it is likely that these shortages will disproportionately affect patients living in these MUAs.

There are several factors that contribute to the shortage of orthopaedic surgeons in MUAs. Multiple challenges exist for physicians in both rural and poor urban settings. These challenges include, but are not limited to, increased call duties, more generalized practice, the limited capacity and resources of community hospitals, and lower physician reimbursement[3]. Improving access to care in MUAs requires a multipronged approach, including systemic changes of our health system. However, identifying and recruiting medical students most likely to practice in underserved areas when they finish orthopaedic surgery training could mitigate one of the factors contributing to lack of access to care. A place to start is to define the attributes of students who have interest in doing such work.

We propose to investigate the factors associated with intention to pursue orthopaedic surgery and, among medical students who plan to become orthopaedic surgeons, factors associated with intention to practice in underserved areas (IPUAs). Previous literature regarding medical students pursuing primary care has shown that those who self-identify as a woman or URM are more likely to report IPUAs[4,5]. This study sought to identify correlations between graduating medical students' demographics, medical school experiences, IPUAs, and their interest to pursue orthopaedic surgery. We hypothesized that students identifying as a woman or belonging to an ethnoracial URM group would have a higher likelihood of reporting intention to practice in underserved areas. We also hypothesized that female or ethnoracial URM medical students would be less likely to be interested in pursuing orthopaedic surgery compared with non-Hispanic (NH) White male students.

Methods

Deidentified, individual-level data were compiled from the Association of American Medical Colleges (AAMC) Student Record System (SRS)[6] for a national cohort study. The study population included 92,012 US matriculants to MD-granting medical schools enrolling between the academic years of 2007 to 2008 and 2011 to 2012. Data from the SRS tracked students' progress from matriculation through graduation. Between 2013 and 2017, 88,059 (95.7%) of all students in the cohort had graduated. Data were also collected from the AAMC Graduation Questionnaire (GQ), which is a national annual survey of graduating medical students administered between February and June in the year of graduation[7]. In addition, before analysis, deidentified records for graduating medical students obtained from the GQ databank were combined for years 2013 to 2017.

The study's data set includes the following categories combined from the AAMC SRS and GQ:sex, race/ethnicity, age at matriculation, parental educational level, degree program, planned specialty, intention to practice in underserved area, self-reported total debt on graduation, scholarship awarded during medical school, and participation in medical school electives. All data were confidential and anonymous, and the protocol was approved by the Albany Medical College Institutional Review Board.

To determine first-generation status, parents' education of "some college" or less for both parents were included in the first-generation classification. If a student listed either parent's educational status as college degree or higher, the student was placed in the continuing-generation classification. Open-ended age at matriculation responses was used to create a binary variable to identify students who were younger than 23 vs. 23 or

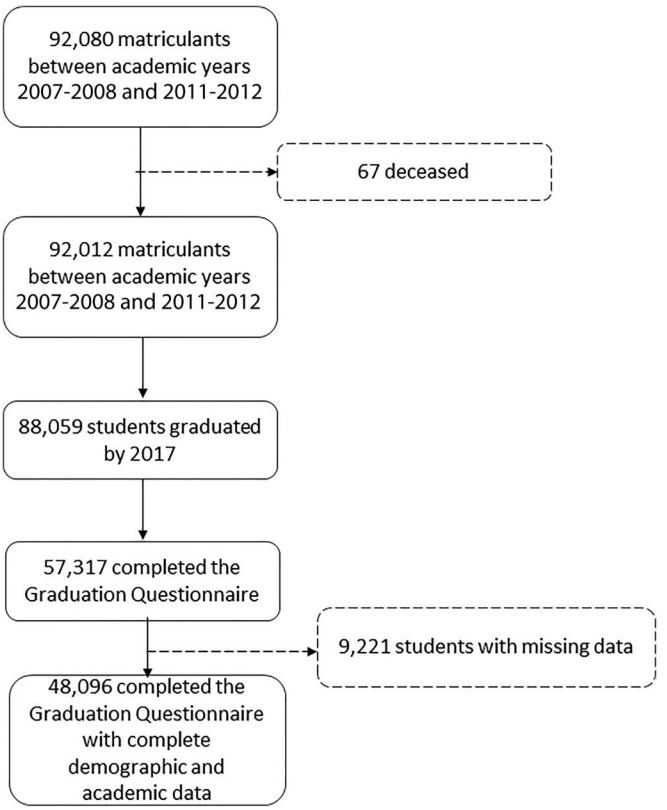

Fig. 1

Study sample size flowchart of respondents included in analysis meeting criteria that include completed Association of American Medical Colleges (AAMC) Graduation Questionnaire and response to specialty interest.

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TABLE I Characteristics of Graduation Questionnaire Participants from US Allopathic Medical Schools from 2007 to 2008 to 2011 to 2012†

Characteristic (N [%])	Nonorthopaedic Intending Students (N = 45,579)	Orthopaedic Intending Students (N = 2,517)	P value
Gender***			<0.001
Male	22,997 (50.5%)	2,104 (83.6%)	
Female	22,582 (49.5%)	413 (16.4%)	
Race/ethnicity***			<0.001
NH White	29,589 (64.9%)	1,921 (76.3%)	
NH Asian	8,416 (18.5%)	274 (10.9%)	
NH Black/African American	1,933 (4.2%)	91 (3.6%)	
NH Native American/Alaska Native	87 (0.2%)	3 (0.1%)	
NH Hawaiian Native/Other Pacific Islander	71 (0.2%)	2 (0.1%)	
Hispanic	3,124 (6.9%)	112 (4.5%)	
NH multiracial	1,282 (2.8%)	62 (2.5%)	
NH unknown/other	1,077 (2.4%)	52 (2.1%)	
Total debt*			0.048
No debt	6,355 (13.9%)	347 (13.8%)	
<100,000	6,801 (14.9%)	354 (14.1%)	
$100,000-$199,999	12,429 (27.3%)	627 (24.9%)	
$200,000-$299,999	11,013 (24.2%)	641 (25.5%)	
>$300,000	3,311 (7.3%)	203 (8.1%)	
Generation status**			0.001
First-generation college graduate	5,193 (11.4%)	234 (9.3%)	
Continuing-generation student	40,386 (88.6%)	2,283 (90.7%)	
Age at matriculation			0.30
Younger than 23 yrs	25,088 (55.0%)	1,412 (56.1%)	
Older than 23 yrs	20,491 (45.0%)	1,105 (43.9%)	
Degree program***			<0.001
MD	42,920 (94.2%)	2,435 (96.8%)	
Dual degrees	2,659 (5.8%)	82 (3.3%)	
Intention to practice in underserved areas***			<0.001
No	33,141 (72.7%)	2,193 (87.1%)	
Yes	12,224 (26.8%)	310 (12.3%)	
Acquired a scholarship			0.98
No	17,666 (38.8%)	975 (38.7%)	
Yes	27,695 (60.8%)	1,530 (60.8%)	
Experience in providing health education in the community			0.59
No	27,462 (60.3%)	1,503 (59.7%)	
Yes	18,117 (39.8%)	1,014 (40.3%)	
Participated in a community-based research project**			0.005
No	33,114 (72.7%)	1,893 (75.2%)	
Yes	12,465 (27.4%)	624 (24.8%)	
Experience related to cultural awareness and cultural competency***			<0.001
No	14,025 (30.8%)	873 (34.7%)	
Yes	31,554 (69.2%)	1,644 (65.3%)	
Participated in educating students about careers in health professions or biological sciences			0.34
No	24,946 (54.7%)	1,353 (53.8%)	
Yes	20,633 (45.3%)	1,164 (46.3%)	

continued

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TABLE I (*continued*)

Characteristic (N [%])	Nonorthopaedic Intending Students (N = 45,579)	Orthopaedic Intending Students (N = 2,517)	P value
Experience with a free clinic for the underserved population*			0.015
No	11,789 (25.9%)	706 (28.1%)	
Yes	33,790 (74.1%)	1,811 (72.0%)	
Experience related to health disparities***			<0.001
No	14,137 (31.0%)	885 (35.2%)	
Yes	31,442 (69.0%)	1,632 (64.8%)	
Global health experience***			<0.001
No	31,571 (69.3%)	1,965 (78.1%)	
Yes	14,008 (30.7%)	552 (21.9%)	
Learned the proper use of the interpreter when needed			0.78
No	11,650 (25.6%)	637 (25.3%)	
Yes	33,929 (74.4%)	1,880 (74.7%)	
Learned another language to improve communication with patients***			<0.001
No	34,355 (75.4%)	2,030 (80.7%)	
Yes	11,224 (24.6%)	487 (19.4%)	
Worked on a research project***			<0.001
No	13,509 (29.6%)	286 (11.4%)	
Yes	32,070 (70.4%)	2,231 (88.6%)	

*p < 0.05; **p < 0.01; ***p < 0.001. †Values may not add up to total (n) due to missing data. CI = 95% confidence interval, dual degrees = MD-MPH, MD-MBA, MD-PhD, NH = non-Hispanic, and SE = standard error.

older. Race/ethnic categorization was determined based on the self-identification of students, which included NH White, NH Black/African American, NH Asian, NH Native American or Alaska Native, NH Hawaiian Native or other Pacific Islander, Hispanic, and unknown/other. Students self-reporting more than one racial/ethnic category were categorized as multiracial. Total debt at graduation was coded into 5 levels: no debt; < $100,000; $100,000 to $199,999; $200,000 to $299,999; and greater than or equal to $300,000.

Descriptive statistics for demographic factors were generated by reporting frequencies and percentages. Chi-square analyses were performed to determine significance in distribution between students interested in orthopaedics vs. other specialties. Multivariable logistic regression models were performed to estimate the adjusted odds ratios for the effects of covariates on students' intention to pursue orthopaedics and practice in underserved areas using 2 models to capture demographic and medical school experiences. We report adjusted odds ratio and 95% confidence interval, and statistical analyses were performed using Stata version 16.1 (StataCorp).

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This research was funded by a Medical Education Scholarship Research and Evaluation grant from AAMC's Northeast Group on Educational Affairs. Neither the Northeast Group on Educational Affairs nor the AAMC played a role in the investigation.

Results

Of the 92,080 medical students who matriculated in the academic years of 2007 to 2008 through 2011 to 2012, 88,059 (95.7%) students graduated by 2017. Among the 88,059 medical school graduates from US MD-granting schools, 57,317 (65.1%) indicated a specialty preference as respondents/participants in the GQ. Of these, 48,096 (83.9%) students had complete demographic, financial, and medical school elective data and were included in the study (Fig. 1). Among 48,096 US medical students included in the study sample, 2,517 (5.2%) reported intention for a career in orthopaedic surgery. Compared with all medical school matriculants who graduated by 2017, students in the study cohort (those who graduated indicated a specialty preference and met inclusion criteria for data) were similarly distributed by sex (women: 47.8% vs 47.8%; p = 0.92), with a higher proportion of NH White students (59.5% vs 65.5%; p < 0.001) in the study cohort. A significantly higher percentage of students intending to pursue orthopaedic surgery were men, compared with those intending to pursue other specialties (83.6% vs. 50.5%; p < 0.001) (Table I). A significantly lower portion of students intending to pursue orthopaedic surgery identified as first-generation college graduates, NH Black/African American, or Hispanic compared with those who reported intention for nonorthopaedic specialties (Table I).

Regarding medical school experiences, a significantly lower percentage of students pursuing orthopaedic surgery reported experiences related to health disparities, cultural awareness and

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cultural competency, global health, or learning another language to improve communication with patients when compared with nonorthopaedic students. When exploring IPUAs, lower percentage of students intending to pursue orthopaedics planned to practice in underserved areas than those who intended to pursue other specialties (Table I).

Intention for Orthopaedic Surgery

Adjusted logistic regression models were used to estimate the effect of each covariate on the likelihood of intention to pursue orthopaedic surgery as a career. Table II shows results demonstrating the correlation of demographic factors on students' intention to pursue orthopaedic surgery. Men were more likely than women to report intention for orthopaedic surgery (5.0 [4.4-5.6]). After adjusting for financial and other demographic information, Hispanic students (0.6 [0.5-0.7]) and NH Asian students (0.5 [0.5-0.6]) were significantly less likely to report intent for orthopaedic surgery. Students intending to pursue orthopaedic surgery were less likely to have dual degrees (0.3 [0.2-0.5]) or identify as first-generation college graduates (0.8 [0.7-0.9]).

TABLE II Correlation of Demographic Factors with Intention to Pursue Orthopaedic Surgery Among Graduation Questionnaire Participants Who Matriculated Between 2007 to 2008 and 2011 to 2012*

Covariate or Predictor (Reference)	Adjusted Odds Ratio (95% CI)
First-generation college graduate (continuing-generation college graduate)	**0.8** (**0.7-0.9**)
Male (female)	**5.0** (**4.4-5.6**)
Age at matriculation older than 23 yrs (younger than 23 yrs)	1.1 (1.0-1.2)
Scholarship (no scholarship)	1.1 (1.0-1.2)
Total debt at graduation (no debt)	
<100,000	0.9 (0.8-1.1)
$100,000-$199,999	0.8 (0.7-1.0)
$200,000-$299,999	0.9 (0.8-1.0)
>$300,000	1.0 (0.8-1.2)
Ethnoracial groups (NH White)	
NH Asian	**0.5** (**0.5-0.6**)
NH Black/African American	0.9 (0.7-1.2)
NH Native American/Alaska Native and Hawaiian Native/Other Pacific Islander	0.5 (0.2-1.5)
Hispanic	**0.6** (**0.5-0.7**)
NH multiracial	0.8 (0.6-1.0)
NH unknown/other	0.8 (0.6–1.0)
Degree program (MD)	
Dual degrees (e.g., MD-MPH, MD-MBA, MD-PhD)	**0.3** (**0.2-0.5**)

*CI = 95% confidence interval and NH = non-Hispanic. Bold indicates significant values.

Next, we explored the correlation of medical school curricular and extracurricular experiences on students' intention to pursue orthopaedic surgery. Students intending to pursue orthopaedics were significantly more likely to have worked on a research project (3.4 [3.0-3.8]) (Table III). Orthopaedic students were less likely to have participated in a global health experience (0.7 [0.6-0.8]) or to have learned another language to improve communication with patients (0.8 [0.7-0.9]). No significant association was found regarding the remaining experiences (Table III).

Intention to Practice in Underserved Areas

To understand how demographic factors correlate with students' intention to practice in underserved areas among orthopaedic students, multivariable logistic regression analysis was performed (Table IV). Compared with female students interested in orthopaedic surgery, male students were less likely to report an intention to practice in underserved areas (0.6 [0.4-0.8]). Students who reported receiving a scholarship (1.5 [1.1-2.0]) were more likely to report an intent to practice in underserved areas. Among ethnoracial groups, NH Black/African American students (5.0 [3.0-8.2]) and Hispanic students (2.0 [1.1-3.5]) were significantly more likely than NH White students to report IPUAs (Table IV). Students' parental education background, age at matriculation, total debt at graduation, and degree

TABLE III Correlation of Medical School Experiences with Intention to Pursue Orthopaedic Surgery Among Graduation Questionnaire Participants Who Matriculated Between 2007 to 2008 and 2011 to 2012*

Covariate or Predictor (Reference)	Adjusted Odds Ratio (95% CI)
Experience in providing health education in the community	1.1 (1.0-1.3)
Participated in a community-based research project	0.9 (0.8-1.0)
Experience related to cultural awareness and cultural competency	0.9 (0.8-1.0)
Participated in educating students about careers in health professions or biological sciences	1.1 (1.0-1.2)
Experience with a free clinic for the underserved population	0.9 (0.9-1.0)
Experience related to health disparities	0.9 (0.8-1.0)
Global health experience	**0.7** (**0.6-0.8**)
Learned the proper use of the interpreter when needed	1.09 (0.97-1.23)
Learned another language to improve communication with patients	**0.8** (**0.7-0.9**)
Worked on a research project	**3.4** (**3.0-3.8**)

*CI = 95% confidence interval. Bold indicates significant values.

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TABLE IV Correlation of Demographic Factors with Intention to Practice in Underserved Areas Among Graduation Questionnaire Participants Interested in Orthopaedic Surgery*

Covariate or Predictor (Reference)	Adjusted Odds Ratio (95% CI)
First-generation college graduate (continuing-generation college graduate)	1.0 (0.6-1.6)
Male (female)	**0.6** (**0.4-0.8**)
Age at matriculation older than 23 yrs (younger than 23 yrs)	0.9 (0.6-1.1)
Scholarship (no scholarship)	**1.5** (**1.1-2.0**)
Total debt at graduation (no debt)	
<100,000	1.1 (0.7-1.9)
$100,000-$199,999	1.4 (0.9–2.3)
$200,000-$299,999	1.3 (0.8–2.1)
>$300,000	1.8 (1,0–3.1)
Ethnoracial groups (NH White)	
NH Asian	1.1 (0.7-1.8)
NH Black/African American	**5.0** (**3.0-8.2**)
NH Native American/Alaskan Native and Hawaiian Native/Pacific Islander	3.1 (0.31-30.3)
Hispanic	**2.0** (**1.1-3.5**)
NH multiracial	1.1 (0.5–2.6)
NH unknown/other	0.9 (0.3-2.6)
Degree program (MD)	
Dual degrees (e.g., MD-PhD, MD-MPH, MD-MBA)	1.0 (1.0-1.0)

*CI = 95% confidence interval, and NH = non-Hispanic. Bold indicates significant values.

TABLE V Correlation of Medical School Experiences with Intention to Practice in Underserved Areas Among Graduation Questionnaire Participants Interested in Orthopaedic Surgery*

Covariate or Predictor (Reference)	Adjusted Odds Ratio (95% CI)
Experience in providing health education in the community	1.3 (1.0-1.6)
Participated in a community-based research project	**1.8** (**1.4-2.3**)
Experience related to cultural awareness and cultural competency	1.0 (0.7-1.4)
Participated in educating students about careers in health professions or biological sciences	1.0 (0.8-1.2)
Experience with a free clinic for the underserved population	1.3 (1.0-1.8)
Experience related to health disparities	0.9 (0.7-1.4)
Global health experience	**1.9** (**1.5-2.5**)
Learned the proper use of the interpreter when needed	0.8 (0.6-1.2)
Learned another language to improve communication with patients	1.2 (0.9-1.6)
Worked on a research project	0.9 (0.6-1.2)

*CI = 95% confidence interval and NH = non-Hispanic. Bold indicates significant values.

program were not associated with intent to practice in an underserved area.

Medical students' experiences correlated with IPUAs, those who intended to pursue orthopaedics who had participated in a community-based research project (1.8 [1.4-2.3]) or in a global health experience (1.9 [1.5-2.5]) were significantly more likely to report IPUAs (Table V). No other significant association was found for remaining medical school experiences.

Discussion

The benefits of diversity in orthopaedic surgery are well recognized. These benefits include diverse perspectives that increase innovation and creativity, advancement of the medical profession, and improved care through creation of medical teams that are better able to bridge cultural, experiential, and linguistic gaps; this results in more effective communication and understanding for the patient's concerns and their barriers to care[8-10]. In this study, we provide evidence of another potential benefit of ethnoracial and sex diversity in orthopaedic surgery: intention to practice in underserved areas. Previous studies have explored the characteristics of medical students interested in working with underserved populations[3,11,12]; this study uses national data to investigate the characteristics of students who intend to pursue *orthopaedic surgery* with respect to intent to practice in an underserved area. Those who identified as women, ethnoracial URMs, and first-generation college graduates comprised a significantly lower percentage of students pursuing orthopaedic surgery than all other specialties. We identified specific demographic factors that were associated with intention to pursue orthopaedic surgery and factors that were associated with IPUAs. Our study demonstrated that students intending to pursue orthopaedic surgery who identified as a woman, NH Black/African American, or Hispanic were more likely to report an intention to practice in underserved areas compared with their male and NH White counterparts, respectively. These results therefore confirm our hypotheses.

Our study had several limitations. Because these survey responses are self-reported, variability exists in students' interpretation of survey questions. For example, students may have different understandings of an underserved area. In addition, our analyses do not include respondents with incomplete data. Our study method can establish correlation but does not establish causation. Finally, we studied "intent" reported by the student and do not know whether those who intended to do so actually eventually will practice in underserved areas. Future directions should include prospective studies to investigate directionality of these variables associated with IPUAs, along with follow-up to determine whether those who IPUAs actually do so.

Nevertheless, our findings that medical students pursuing orthopaedic surgery were less likely to report IPUAs than other specialties are concerning because it may compound the systemic issues that already limit access to orthopaedic care. Our study found a significant correlation between orthopaedic students' medical school experiences related to cultural competence and IPUAs. Further studies are needed to determine whether an increase in these experiences leads to an increase in IPUAs. Overall, students applying to orthopaedic surgery were less likely to participate in medical experiences related to global health or learning additional languages. In previous years, many residency programs placed greater value on high board scores when considering applicants for interview[13]. In 2018, 64% of all US specialties programs required a "target score" for the United States Medical Licensing Examination (USMLE) step 1 when considering which applicants to interview, whereas only 34% would interview an applicant with a "pass" only[13]. The USMLE step 1 reporting will transition to a pass/fail only outcome on or after January 26, 2022. As this transition occurs, we hope that our findings will inform and motivate orthopaedic surgery residency programs to value candidates who have shown their dedication to community health and health equity by participating in community research or a global health experience. These students are also more likely to report IPUAs, but regardless of this correlation, these experiences are important for all future orthopaedic surgeons.

In addition, orthopaedic surgery must continue to foster diversity in the field. Our study demonstrated that female and NH Black/African American, Hispanic, and first-generation medical school graduates were less likely to apply to orthopaedic surgery residency. Further research should be performed to identify the reasons behind this lack of interest in orthopaedic surgery. One study suggests that mentorship and early exposure are critical for increasing female and underrepresented minority interest in orthopaedic surgery[14]. Beyond the significant correlation that these trainees intend to work in underserved areas, evidence also supports benefits for patient outcomes[8]. These factors reinforce our recommendation for orthopaedic residency programs to value medical school experiences focused on health equity because we found these experiences to be lacking among intended orthopaedic surgery students in our study.

Programs such as Nth Dimensions, the J. Robert Gladden Orthopaedic Society, and The Perry Initiative have also been instrumental in increasing early exposure and working toward establishing the perception among URM and female trainees that they are welcome and wanted and capable of becoming orthopaedic surgeons[15-17]. The American Academy of Orthopaedic Surgeons and its Diversity Advisory Board is also committed to promoting the growth of diversity among its surgeons[18]. Despite these efforts, one study found that the percentage of URMs in orthopaedic surgery residency training programs has decreased over time[19]. This aligns with our study's findings of lower intention to pursue orthopaedic surgery from URM medical student graduates. A study by McDonald et al. found that although URM residents only accounted for 6% of the overall resident population, they accounted for 17.5% of all residents who underwent attrition[20]. Attrition is also more common among female orthopaedic residents[21]. Even with this evidence, it remains unclear why there has been a decrease in URM residents over the past decade while the number of female residents has increased[19]. What remains clear is increasing diversity within the orthopaedic surgery specialty is complex and must be considered from several vantage points.

This study showed that characteristics associated with the propensity of medical students to practice in underserved areas are underrepresented in medical students planning to apply to orthopaedic surgery. This study provides evidence to support efforts to increase diversity in our specialty, which should be a priority for all orthopaedic surgery residency programs. Future studies can determine whether successful recruitment of students with these characteristics actually diminishes the negative impact of orthopaedic surgeon maldistribution and shortages on access to care. ■

Michele Cerasani, MD[1]
Moje Omoruan, MD[2]
Carolyn Rieber, BS[1]
Mytien Nguyen, MS[3]
Hyacinth R.C. Mason, MPH, PhD[4]
Brian Clair, MD, MBA[5]
Steven C. Stain, MD[5]
Amadeus R. Mason, MD[6]
L Scott Levin, MD[7]

[1]Albany Medical College, Albany, New York

[2]SUNY Upstate Medical University, Syracuse, New York

[3]MD-PhD Program, Yale University School of Medicine, New Haven, Connecticut

[4]Tufts University School of Medicine, Boston, Massachusetts

[5]Lahey Hospital and Medical Center, Burlington, Massachusetts

[6]Department of Orthopaedic Surgery and Family Medicine at Emory University, Atlanta, Georgia

[7]Department of Orthopaedic Surgery, Department of Surgery (Division of Plastic Surgery) Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania

E-mail address for L.S. Levin: Scott.levin@pennmedicine.upenn.edu

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