



## AOA Critical Issues in Education

# Evolution of Medical Students' Interest in Orthopaedic Surgery Careers from Matriculation to Graduation

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*Investigation performed at Washington University in St. Louis, Missouri*

**Introduction:** Little is known about risk factors for changes in students' interest in orthopaedics during medical school. We aimed to identify variables associated with diminished (vs. sustained) and emerging (vs. no) plans to become board certified in orthopaedic surgery.

**Methods:** We conducted a retrospective national-cohort study of students who matriculated in US MD-granting medical schools in academic years 1993 to 1994 through 2000 to 2001. The outcome measure was the evolution of students' board-certification plans in orthopaedic surgery from matriculation to graduation using responses on the Association of American Medical Colleges' Matriculating Student Questionnaire and Graduation Questionnaire. Covariates included demographic, attitudinal, experiential, and career intention variables.

**Results:** Of 53,560 graduates with complete data, 2,765 students reported diminished interest in becoming board certified in orthopaedics, 1,345 reported emerging interest, and 1,327 reported sustained interest. In multivariable logistic regression models, students who were female (adjusted odds ratio [aOR] 1.83, 95% confidence interval [CI] 1.43-2.34), Asian (aOR 1.46, 95% CI 1.18-1.82), reported greater importance of social responsibility (aOR 1.16, 95% CI 1.02-1.33) and prestige

*continued*

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Data were used with permission from each outside source. As part of the data-use agreement with each source, the source's staff reviewed the manuscript before submission.

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(aOR 1.20, 95% CI 1.10-1.30) in choosing a medicine career, and planned full-time university faculty careers (aOR 1.58, 95% CI 1.33-1.89) at graduation were independently more likely to have diminished (vs. sustained) interest. Students who participated in research and/or authorship electives (aOR 3.50, 95% CI 3.00-4.07) and who attended private institutions (aOR 1.23, 95% CI 1.10-1.39) were more likely to have emerging (vs. no) interest.

**Conclusions:** Twice as many students lost interest than gained interest in orthopaedics during medical school, and the cohort of students interested in orthopaedics became less diverse over the course of medical school. Several risk factors amenable to change were identified. Interventions that target these risk factors are warranted to increase the diversity of the orthopaedic surgery workforce.

## Introduction

Choosing a medical specialty is a complex decision involving student characteristics, medical school characteristics, and students' perceptions of medical specialties<sup>1</sup>. Students may have preconceived notions about their careers when they enter medical school, but they are often undecided or change their minds about their specialties<sup>2-4</sup>. In a longitudinal study at one US medical school, orthopaedics had the largest loss of student interest among all specialties from matriculation to graduation<sup>3</sup>. Nationally, 7.2% of medical students select orthopaedic surgery on the Association of American Medical Colleges (AAMC) Matriculating Student Questionnaire (MSQ), compared with 4.0% of students at graduation on the AAMC Graduation Questionnaire (GQ), demonstrating a loss of interest during medical school<sup>4,5</sup>. Variables associated with gaining or losing interest in orthopaedic surgery careers during medical school nationally are not well understood.

It is important that orthopaedic surgery departments understand factors associated with the evolution of students' interest in orthopaedics during medical school, particularly because orthopaedics is one of the most competitive and least demographically diverse specialties, with a match rate of 73% for US MD seniors in 2023<sup>6</sup>. Women comprised 20.4% of orthopaedic residents in the United States in 2023<sup>7</sup>, the lowest proportion of women in any specialty<sup>8</sup>. Minority-trainee representation in orthopaedics, which includes residents who are underrepresented in medicine (URiM) and Asian trainees<sup>9</sup>, averaged 20.2% from 2001 to 2008<sup>10</sup> with an increase from 19.6% in 2006 to 21.0% in 2023<sup>7,11-13</sup>. Importantly, match rates for women and URiM candidates reflect their application rates in orthopaedics<sup>14</sup>. By identifying factors that are associated with changes in students' interest in orthopaedics during medical school, educators can better target recruitment efforts and interventions to promote and sustain students' interest in orthopaedics during medical school.

Therefore, we sought to identify demographic, attitudinal, experiential, and career intention variables that were associated with the evolution of students' interest in orthopaedic surgery board certification from medical-school matriculation to graduation, with specific interest in variables associated with diminished (vs. sustained) intent and emerging (vs. no) intent to become board certified in orthopaedics.

## Methods

We conducted a retrospective study of a national cohort of all 129,860 medical students who matriculated in US

Liaison Committee on Medical Education (LCME)-accredited medical schools in academic years (AYs) 1993 to 1994 through 2000 to 2001. This article reports on a secondary analysis of existing individual-level data for this national cohort of medical-school matriculants who graduated in calendar years 1997 to 2013. Individual records were linked for each student and deidentified by staff at the AAMC before providing the data to us for analysis. The Institutional Review Board at Washington University in St. Louis determined this study to be nonhuman subjects research IRB # 202012115. The Strengthening the Reporting of Observational Studies in Epidemiology guidelines were followed<sup>15</sup>.

## Covariates

We obtained student demographic data from the AAMC Student Records System<sup>16</sup>, including self-reported sex (female vs. male) and race/ethnicity (categorized as White, Asian, URiM, including all students who self-reported Black/African American, Hispanic/Latino ethnicity, Native Hawaiian/Pacific Islander, American Indian/Native Alaskan, alone or in addition to any other race/ethnicity, and other/unknown/no response). In addition, the AAMC provided data for each student in our database describing whether their medical school was considered a research-intensive (Top-40) institution based on all 2007 to 2008 federal research expenditures<sup>17</sup>.

At the beginning of each AY, incoming medical students voluntarily complete the AAMC MSQ<sup>4</sup>. From the MSQ, we examined students' parents' highest level of education (categorized as first-generation college graduate [neither parent completed 4-year BA/BS degree], continuing-generation college graduate [at least one parent completed BA/BS degree, with or without further graduate or professional education]). We also used 3, previously developed multi-item scales using MSQ items measuring the importance of innovation and research, social responsibility, and prestige in students' choice of medicine as a career, with higher mean scores on each scale indicating greater importance<sup>18</sup>. MSQ response rates averaged 93.5% in this cohort (Roskovensky L, BA, AAMC Data Operations and Services, email communication, August 30, 2022).

First-attempt, 3-digit US Medical Licensing Examination Step 1 scores were obtained with permission from the National Board of Medical Examiners. Scores were analyzed as a 5-category variable (failing and the 4 quartiles of passing scores), based on pass/fail cutoff scores for each year.

Graduating medical students voluntarily complete the AAMC GQ in the spring semester before graduation<sup>5</sup>. From the GQ, we examined students' research and/or authorship activities during medical school using 2 GQ items and created a dichotomous variable (participated in neither research nor authorship activity or participated in one or both of research and authorship), total debt at graduation (no debt, \$1–\$99,999, or ≥\$100,000), and their evaluation of their clinical experience during the surgery clerkship (excellent, good, or fair/poor). We also examined students' career preferences (full-time university faculty, full-time nonacademic clinical practice, or other/undecided [including state/federal agency, medical/healthcare administration without practice, full-time nonuniversity research scientist, other, or undecided]), and degree program at graduation (MD [including BA/MD or BS/MD], MD/PhD, or MD/other-advanced degree) and whether each student attended a public or private medical school. GQ response rates averaged 69.3% in this cohort (Roskovensky L, BA, AAMC Data Operations and Services, email communication, August 30, 2022).

### Outcome

Students included in the analysis had to have responded to 2 items on both the MSQ and GQ to determine the change in students' interests in orthopaedic-surgery specialty choice from matriculation to graduation. Students were first asked, "Are you planning to become certified in one of the 25 general specialties listed below?" The 25 specialties listed refer to the general specialties in which the American Board of Medical Specialties member boards offer board certification<sup>19</sup>. Students were offered 3 response options (yes, no, or undecided). If they responded "yes," they were asked, "If yes, what general specialty are you considering?" We created a 4-category outcome variable for analysis to describe the evolution of students' board-certification plans in orthopaedics from matriculation to graduation: (1) no plans (did not select orthopaedic surgery on the MSQ or GQ); (2) diminished plans (selected orthopaedic surgery on the MSQ but not the GQ); (3) emerging plans (selected orthopaedic surgery on the GQ but not the MSQ); and (4) sustained plans (selected orthopaedic surgery on both the MSQ and GQ).

Students who completed the MSQ in AY 1997 to 1998 were excluded from analysis because of suspected irregularities in the specialty-preference data collected in that AY (David Matthew, PhD, AAMC, email communication, April 11, 2019). Therefore, we also created a 2-category variable for analysis to examine potential differences between students in this cohort who completed the MSQ either before or after AY 1997 to 1998 in association with our outcome of interest.

### Data Analysis

We examined bivariate associations between the 4-category orthopaedic surgery evolution variable and each covariate of interest using  $\chi^2$  tests and one-way analyses of variance. Next, 2 multivariable logistic regression models were run to identify risk factors independently associated with the evolution of students' orthopaedic surgery board-certification plans, com-

paring the following groups: (1) students having emerging (vs. no) plans and (2) students having diminished (vs. sustained) plans. Each model included all covariates significantly associated with the evolution of orthopaedic surgery board-certification plans in bivariate tests. Adjusted odds ratios and 95% confidence intervals (CIs) from multivariable logistic regression models are reported. Two-sided *p* values < 0.05 were considered statistically significant. All analyses were performed using IBM SPSS Statistics Version 28 for Windows (IBM).

### Results

Among the 102,220 graduates in years 1997 to 2013, we excluded 45,533 who lacked data for specialty board-certification plans on both the MSQ and GQ, which was necessary for study inclusion. Of the remaining 56,687 graduates, we further excluded 3,127 (5.5%), who lacked complete data for other variables of interest, leaving a sample of 53,560 graduates (Fig. 1). Overall, 2,765 students reported diminished interest in becoming board certified in orthopaedics—more than twice as many as the 1,345 students who reported emerging interest or the 1,327 students who had sustained interest (Table I). In addition, 48,123 (89.8%) students never reported interest in board certification in orthopaedics on the MSQ or GQ. Greater proportions of students who completed the MSQ after (vs. before) AY 1997 to 1998 had both sustained and diminished interest in orthopaedic surgery board certification. All variables shown in Table I were significantly associated with evolution of orthopaedic surgery board-certification plans in bivariate tests.

Table II shows results from 2 logistic regression models. Notably, in both models, students who matriculated after AY 1997 to 1998 were neither more nor less likely than students who matriculated earlier to report either diminished or emerging interest in orthopaedics. Other covariates not independently associated with either diminished or emerging interest in orthopaedic surgery included parent education, attending a research-intensive medical school, and total debt at graduation. Statistically significant results are summarized below.

#### *Diminished (vs. Sustained) Interest*

Of the 4,092 students who reported orthopaedic surgery specialty board-certification plans at matriculation, 2,765 students (67.5%) selected another specialty for board certification at graduation (diminished interest) and 1,327 students (32.4%) had sustained interest in orthopaedics at graduation. As shown in Table II, students who self-identified as female or as Asian, placed greater importance on social responsibility and prestige in choosing medicine as a career, gave lower-than-excellent ratings of their surgical-clerkship experience, planned a full-time university faculty career, and scored in any category below the highest quartile of Step 1 passing scores were independently more likely to have diminished interest in orthopaedics.

Students who placed greater importance on innovation and research in choosing medicine as a career, participated in research and/or authorship electives during medical school, and attended a private medical school were each less likely to have diminished interest in orthopaedics at graduation.

**Emerging (vs. No) Interest**

Of the 49,468 students who did not report orthopaedic surgery board-certification plans at matriculation, 1,345 (2.7%) students had emerging interest in orthopaedics on the GQ. As shown in Table II, students who participated in research and/or authorship electives during medical school and who attended private institutions were each more likely to have emerging interest in orthopaedics at graduation.

Students who self-identified as female or as Asian, placed greater importance of social responsibility in choosing medicine

as a career, gave lower-than-excellent ratings of their surgical-clerkship experience, planned to pursue full-time university faculty careers, graduated with MD/PhD degrees, and scored in any category below the highest quartile of step 1 passing scores were each less likely to have emerging interest in orthopaedics at graduation.

**Discussion**

Overall, twice as many students lost interest in orthopaedics during medical school than students who gained interest.

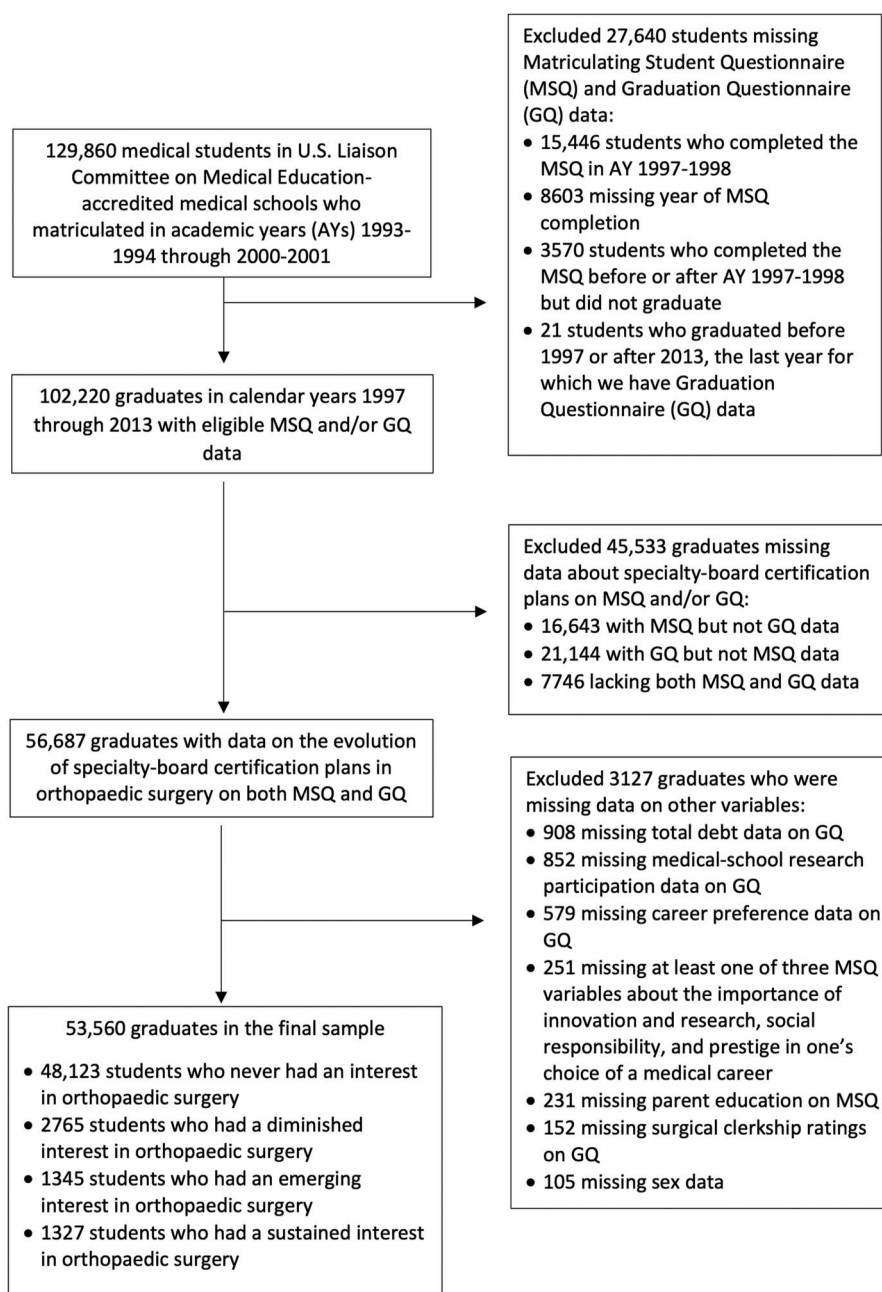


Fig. 1

Flow Diagram for Cohort Selection for Eligibility and Inclusion in Analysis

TABLE 1 Bivariate Associations Between Each Covariate and Change in Orthopaedic Surgery Board-Certification Plans from Matriculation (MSQ) to Graduation (GQ) Among US LCME-Accredited Medical-School Graduates in Calendar Years 1997 to 2013 with Complete Data (N = 53,560) <sup>a</sup>					
Covariates	Total N = 53,560	No Interest n = 48,123	Sustained Interest n = 1,327	Diminished Interest n = 2,765	Emerging Interest n = 1,345
Sex, no. (%) <sup>b</sup>					
Male	29,736	24,971 (84.0)	1,229 (4.1)	2,376 (8.0)	1,160 (3.9)
Female	23,824	23,152 (97.2)	98 (0.4)	389 (1.6)	185 (0.8)
Race/ethnicity, no. (%) <sup>b</sup>					
White	35,926	31,954 (88.9)	1,022 (2.8)	1,957 (5.4)	993 (2.8)
Asian	9,035	8,300 (91.9)	153 (1.7)	410 (4.5)	172 (1.9)
URiM	7,873	7,221 (91.7)	136 (1.7)	356 (4.5)	160 (2.0)
Other/unknown/no response	726	648 (89.3)	16 (2.2)	42 (5.8)	20 (2.8)
Matriculation years, no. (%) <sup>b</sup>					
AYs 1993-1994 through 1996-1997	34,369	31,062 (90.4)	757 (2.2)	1,690 (4.9)	860 (2.5)
AYs 1998-1999 through 2000-2001	19,191	17,061 (88.9)	570 (3.0)	1,075 (5.6)	485 (2.5)
Parent education, no. (%) <sup>b</sup>					
First-generation college graduate	11,128	10,175 (91.4)	200 (1.8)	503 (4.5)	250 (2.2)
Continuing-generation college graduate	42,432	37,948 (89.4)	1,127 (2.7)	2,262 (5.3)	1,095 (2.6)
Importance of factors in choosing medicine as a career at matriculation	53,560	2.74 (0.68)	2.95 (0.57)	2.90 (0.60)	2.84 (0.63)
Innovation and research, mean (SD) <sup>d</sup>	53,560	2.74 (0.68)	2.95 (0.57)	2.90 (0.60)	2.84 (0.63)
Social responsibility, mean (SD) <sup>d</sup>	53,560	3.37 (0.54)	3.15 (0.56)	3.20 (0.55)	3.23 (0.57)
Prestige, mean (SD) <sup>d</sup>	53,560	2.10 (0.94)	2.34 (0.91)	2.42 (0.89)	2.21 (0.94)
Research and/or authorship elective during medical school, no. (%) <sup>b</sup>					
Neither elective reported	22,487	21,085 (93.8)	199 (0.9)	979 (4.4)	215 (1.0)
One or both electives	31,082	27,038 (87.0)	1,128 (3.6)	1,786 (5.7)	1,130 (3.6)
Total debt at graduation, no. (%) <sup>b</sup>					
No debt	8,381	7,453 (88.9)	234 (2.8)	471 (5.6)	223 (2.7)
\$1-\$99,999	24,291	21,984 (90.5)	537 (2.2)	1,216 (5.0)	554 (2.3)
≥\$100,000	20,088	18,686 (89.5)	556 (2.7)	1,078 (5.2)	568 (2.7)
Surgical-clerkship experience, no. (%) <sup>b</sup>					
Excellent	21,795	18,924 (86.8)	806 (3.7)	1,230 (5.6)	835 (3.8)
Good	20,236	18,438 (91.1)	391 (1.9)	1,014 (5.0)	393 (1.9)
Poor/fair	11,529	10,761 (93.3)	130 (1.1)	521 (4.5)	117 (1.0)
Career preferences at graduation, no. (%) <sup>b</sup>					
Full-time clinical practice	27,297	24,234 (88.8)	774 (2.8)	1,568 (5.7)	721 (2.6)
Full-time university faculty	15,312	13,892 (90.7)	337 (2.2)	709 (4.6)	374 (2.4)
Other/undecided	10,951	9,997 (91.3)	216 (2.0)	488 (4.5)	250 (2.3)
Degree at graduation, no. (%) <sup>b</sup>					
MD, BA/MD, BS/MD	52,367	46,997 (89.7)	1,316 (2.5)	2,729 (5.2)	1,325 (2.5)
MD/PhD	726	691 (95.2)	7 (1.0)	20 (2.8)	8 (1.1)
MD/other advanced degree	467	435 (93.1)	4 (0.9)	16 (3.4)	12 (2.6)
School ownership, no. (%) <sup>b</sup>					
Public	32,818	29,632 (90.3)	734 (2.2)	1,719 (5.2)	733 (2.2)
Private	20,742	18,491 (89.1)	593 (2.9)	1,046 (5.0)	612 (3.0)

continued



TABLE 1 (continued)

Covariates	Total N = 53,560	No Interest n = 48,123	Sustained Interest n = 1,327	Diminished Interest n = 2,765	Emerging Interest n = 1,345
Research-intensive medical school, no. (%) <sup>c</sup>					
Yes	17,590	15,848 (90.1)	445 (2.5)	826 (4.7)	471 (2.7)
No	35,970	32,275 (89.7)	882 (2.5)	1,939 (5.4)	874 (2.4)
First-attempt step 1 scores, no. (%) <sup>b</sup>					
Highest quartile of passing	12,649	10,936 (86.5)	543 (4.3)	618 (4.9)	552 (4.4)
Second-highest quartile passing	13,046	11,589 (88.8)	374 (2.9)	695 (5.3)	388 (3.0)
Third-highest quartile passing	12,891	11,721 (90.9)	237 (1.8)	683 (5.3)	250 (1.9)
Lowest quartile passing	12,306	11,403 (92.7)	148 (1.2)	629 (5.1)	126 (1.0)
Failing	2,668	2,474 (92.7)	25 (0.9)	140 (5.2)	29 (1.1)

AYs = academic years, GQ = Graduation Questionnaire, LCME = Liaison Committee on Medical Education, MSQ = Matriculating Student Questionnaire, and URiM = Underrepresented in Medicine (Black/African American, Hispanic/Latino, Native Hawaiian/Pacific Islander, American Indian/Native Alaskan, alone or in combination with any other race/ethnicity). <sup>a</sup>Percentages shown are of each row total in column 2. <sup>b</sup> $\chi^2$  tests,  $p < 0.001$ . <sup>c</sup> $\chi^2$  test,  $p = 0.002$ . <sup>d</sup>Analyses of variance,  $p < 0.001$ .

A net loss was observed in this cohort's choice of orthopaedic surgery for board certification, with 7.6% (4,092/53,560) of matriculating medical students selecting orthopaedic surgery for eventual board certification compared with 5.0% of graduating students. Furthermore, the cohort of interested students became less diverse during medical school, with diminished interest particularly among women and Asian students. Our descriptions of various demographic, attitudinal, experiential, and career intention variables associated with medical students' interest in orthopaedics during medical school can help schools develop interventions to promote diverse students' interest in orthopaedic surgery careers.

#### Diminished Interest in Orthopaedics

We observed diminished interest in orthopaedics among women and Asian students, but not among URiM students. Mentorship is important for students when choosing medical specialties<sup>20,21</sup>, and given the paucity of women, URiM, and Asian faculty in orthopaedics, medical students with these identities may have difficulty identifying mentors sharing similar identities to themselves<sup>22</sup>. Feelings of belonging/social fit also likely play a role in students' specialty choice. In the 2022 GQ All Schools Summary Report, 85.8% of all graduating medical students responded that the strongest influence on their specialty choice was their perceived "Fit with personality, interest, and skills"<sup>23</sup>. Students' loss of interest could be related to their perceived lack of belonging or social fit in orthopaedics<sup>24</sup>. If students feel like they belong in a particular environment (such as an academic department), they are more likely to stay engaged with that environment<sup>25,26</sup>.

Other medical-school experiences, including clerkships, might be related to loss of interest in orthopaedics. Many

students do not receive exposure to orthopaedics before or during medical school, and this lack of exposure could contribute to lower numbers of women and minorities in the field<sup>27</sup>. For example, a 2004 study found that mandatory musculoskeletal medicine instruction in US medical schools was associated with students' greater rates of application to orthopaedic residency programs, and these higher rates of application were more pronounced among women and minority students<sup>28</sup>. However, only 41.8% of US medical schools offer a musculoskeletal block<sup>29</sup>. This paucity of musculoskeletal education during medical school highlights the importance of students' surgical-clerkship experience in specialty selection<sup>30</sup>. Others have reported on the relationship between medical students' clerkship experiences and specialty choice<sup>31,32</sup>. However, to the best of our knowledge, we report a novel association between students' less-than-excellent ratings of their surgery-clerkship and their diminished interest in orthopaedic surgery.

Step 1 scores have been used as a selection criterion by residency program directors until recently<sup>33</sup>, so given the highly competitive orthopaedic match, we expected to find that students with first-attempt step 1 scores below the highest quartile of passing scores were more likely to have diminished interest in orthopaedics. In addition, although a majority of students report that step 1 scores do not affect their specialty choices, students in the upper and lower third of step 1 scores are more likely to change their specialty choice<sup>34</sup>.

Students who attributed greater importance to social responsibility and prestige in choosing a medicine career on the MSQ and graduates interested in pursuing full-time university faculty careers were each more likely to have diminished interest in orthopaedics. These findings are concordant with an

**TABLE II Multivariable Logistic Regression Models to Identify Variables Independently Associated with Each of Diminished (vs. Sustained) and Emerging (vs. No) Interest in Orthopaedic Surgery Board-Certification Plans Among US LCME-Accredited Medical-School Graduates in Calendar Years 1997 to 2013 with Complete Data on the MSQ and GQ**

	Diminished vs Sustained Interest aOR (95% CI) N = 4,092	Emerging vs. No Interest aOR (95% CI) N = 49,468
Sex		
Male	1.00 (Reference)	1.00 (Reference)
Female	1.83 (1.43-2.34)	0.21 (0.18-0.25)
Race/ethnicity		
White	1.00 (Reference)	1.00 (Reference)
Asian	1.46 (1.18-1.82)	0.68 (0.57-0.80)
URiM	0.87 (0.69-1.11)	1.18 (0.98-1.42)
Other/unknown/no response	1.24 (0.69-2.29)	0.96 (0.60-1.52)
Matriculation years		
AYs 1993-1994 through 1996-1997	1.00 (Reference)	1.00 (Reference)
AYs 1998-1999 through 2000-2001	0.90 (0.78-1.04)	1.02 (0.91-1.15)
Parent education		
Continuing-generation college	1.00 (Reference)	1.00 (Reference)
First-generation college graduate	1.16 (0.96-1.42)	0.95 (0.82-1.10)
Importance of factors in choosing medicine as a career		
Innovation and research	0.81 (0.71-0.92) <sup>a</sup>	1.06 (0.96-1.16)
Social responsibility	1.16 (1.02-1.33) <sup>b</sup>	0.88 (0.79-0.97) <sup>c</sup>
Prestige	1.20 (1.10-1.30) <sup>b</sup>	0.99 (0.93-1.05)
Research and/or authorship elective during medical school		
Neither elective reported	1.00 (Reference)	1.00 (Reference)
One or both electives	0.36 (0.30-0.43)	3.50 (3.00-4.07)
Total debt at graduation		
No debt	1.00 (Reference)	1.00 (Reference)
\$1-\$99,999	1.15 (0.94-1.41)	0.90 (0.76-1.06)
≥\$100,000	0.82 (0.80-1.23)	1.03 (0.87-1.21)
Surgical-clerkship experience		
Excellent	1.00 (Reference)	1.00 (Reference)
Good	1.65 (1.41-1.93)	0.53 (0.47-0.60)
Poor/fair	2.30 (1.84-2.88)	0.28 (0.23-0.34)
Career preference at graduation		
Full-time clinical practice	1.00 (Reference)	1.00 (Reference)
Full-time university faculty	1.58 (1.33-1.89)	0.56 (0.49-0.64)
Other/undecided	1.22 (0.97-1.48)	0.87 (0.75-1.01)
Degree at graduation		
MD, BA/MD, BS/MD	1.00 (Reference)	1.00 (Reference)
MD/PhD	1.92 (0.78-4.72)	0.25 (0.12-0.51)
MD/other advanced degree	1.57 (0.49-5.02)	0.94 (0.52-1.69)
School ownership		
Public	1.00 (Reference)	1.00 (Reference)
Private	0.84 (0.72-0.98)	1.23 (1.10-1.39)
Research-intensive medical school		
No	1.00 (Reference)	1.00 (Reference)
Yes	1.06 (0.91-1.24)	0.90 (0.80-1.02)

*continued*

TABLE II (continued)

	Diminished vs Sustained Interest aOR (95% CI) N = 4,092	Emerging vs. No Interest aOR (95% CI) N = 49,468
First-attempt step 1 scores		
Highest quartile of passing	1.00 (Reference)	1.00 (Reference)
Second-highest quartile passing	1.59 (1.33-1.91)	0.75 (0.65-0.86)
Third-highest quartile passing	2.36 (1.93-2.88)	0.51 (0.44-0.60)
Lowest quartile passing	3.36 (2.67-4.24)	0.28 (0.22-0.34)
Failing	4.66 (2.91-7.46)	0.32 (0.22-0.47)

LCME = Liaison Committee on Medical Education, MSQ = Matriculating Student Questionnaire, GQ = Graduation Questionnaire, aOR = adjusted odds ratio, CI = confidence interval, URiM = underrepresented in medicine (Black/African American, Hispanic/Latino, Native Hawaiian/Pacific Islander, American Indian/Native Alaskan, alone or in combination with any other race/ethnicity), and AYs = academic years. <sup>a</sup>aOR <1.00 denotes lower likelihood of diminished (vs. sustained) interest in orthopaedic surgery board certification with each unit increase in importance of innovation and research in choosing medicine as a career on the MSQ. <sup>b</sup>aOR >1.00 denotes greater likelihood of diminished (vs. sustained) interest in orthopaedic surgery board certification with each unit increase in importance of social responsibility and of prestige in choosing medicine as a career on the MSQ. <sup>c</sup>aOR <1.00 denotes lower likelihood of emerging (vs. no) interest in orthopaedic surgery board certification with each unit increase in importance of social responsibility in choosing medicine as a career on the MSQ.

earlier study in which students reporting greater importance of social responsibility were more likely to choose primary-care (vs. all non-primary-care) specialties<sup>18</sup>, whereas students attributing greater importance to prestige and innovation/research and graduates pursuing faculty careers were less likely to choose primary-care specialties<sup>18</sup>. We postulate that students who place greater importance on social responsibility are more likely to choose primary-care specialties and practice in underserved areas<sup>18,35</sup>. Given persistent shortages of orthopaedic surgeons practicing in rural and other underserved areas<sup>36-39</sup>, understanding why students who endorsed greater importance of social responsibility in choosing medicine and selected orthopaedic surgery at matriculation were more likely to have diminished interest in orthopaedics at graduation warrants further investigation.

### Emerging Interest in Orthopaedics

The positive association between research/authorship electives during medical school and emerging interest in orthopaedics could be driven by orthopaedics' highly competitive match screening criteria<sup>6,40</sup>. Students may participate in research activities to bolster the competitiveness of their application rather than a sincere interest in becoming an orthopaedic surgeon-scientist. In our study, matriculating students who attributed greater importance to social responsibility in choosing a medical career, MD/PhD graduates, and graduates interested in full-time faculty appointments were each less likely to have an emerging interest in orthopaedics. As noted above, endorsing greater importance of social responsibility in one's choice of a medical career has been associated with choosing primary-care specialties<sup>18</sup>. The latter 2 findings raise concerns about the future of surgeon-scientists in orthopaedics. Lack of emerging interest in orthopaedics could be due to a lack of scientific mentorship<sup>41</sup>, students' concerns about

the research environment in orthopaedics, or the competitiveness of research funding for surgeon-scientists<sup>42</sup>.

Students who attended private medical schools were more likely to have had an emerging interest in orthopaedics than their peers in public schools. It is possible that private universities may provide advantages by offering opportunities to engage in orthopaedic research projects that help students build competitive residency applications, or that they have more resources and opportunities to be mentored by orthopaedic surgeons. By comparison, public MD-granting medical schools historically produced a higher percentage of primary-care graduates than private MD-granting schools<sup>43</sup>.

### Strengths and Limitations

A strength of this large national-cohort study of students from all US LCME-accredited medical schools is that it allows us to draw conclusions that are generalizable across all US medical graduates. However, we cannot infer causation from the associations we observed. There are other notable limitations. As a secondary analysis of existing data for an older cohort, data were collected for different aims, primarily to examine associations between long-term outcomes (e.g., board certification, faculty appointment/promotion, and federal grant awards) and each of many demographic, attitudinal, academic, and experiential variables. Thus, there are likely several unmeasured variables associated with diminished and emerging interest in orthopaedic surgery. In this cohort, only 52% of students had complete data for all variables of interest, which introduces the potential for selection bias and limits generalizability. We excluded students who lacked data on the MSQ and GQ specialty-choice items, which was necessary to examine specialty-choice change from matriculation to graduation; nevertheless, among 56,687 graduates with responses to both the MSQ and GQ specialty-choice items, only



3,127 (5.5%) were excluded due to missing data for other variables in the analysis (Fig. 1). Notably, little has changed in the selection criteria for and the demography of orthopaedic residents in recent years. Orthopaedics has been and continues to be the least diverse ACGME specialty<sup>8</sup>; thus, many of our findings are likely still relevant to more recent graduates. The dearth of women and URiM residents in orthopaedics reflects the demographics of interested applicants<sup>14</sup>. Future research with more recent national cohorts of medical students is warranted.

Although lack of match data and data for other unmeasured variables, such as perceived belonging in orthopaedics<sup>24</sup> and mentorship<sup>22</sup>, is a limitation, this national study provides a comprehensive analysis of variables associated with changes in medical students' interest in orthopaedics, many of which are amenable to intervention.

### Conclusions

Twice as many students lost interest than gained interest in orthopaedics during medical school. Notably, women and Asian students were at increased risk of diminished interest in orthopaedics, which represents a concerning loss of diversity in the orthopaedic-training pipeline. Diminished interest in orthopaedics could be due to unmeasured variables, such as a lack of belonging<sup>24</sup>, mentorship<sup>22</sup>, and/or exposure to dedicated musculoskeletal orthopaedics education<sup>28,30</sup>. Although students who participated in research and/or authorship during medical school were more likely to gain interest in orthopaedics, research/authorship activities may be related to the competitive match

environment and screening criteria for residency programs. A better understanding of these and other risk factors related to losing or gaining interest in orthopaedic surgery careers could help inform the development of interventions aimed at increasing the diversity of the orthopaedic surgery applicant pool. ■

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