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AOA Critical Issues in Education

An Updated Demographic Profile of Orthopaedic Surgery Using a New ABOS Data Set

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Introduction: The orthopaedic surgery physician workforce is predominately White and male and has been identified as the least diverse medical specialty. Increasing efforts toward diversification within orthopaedic surgery are underway. Evaluating the effectiveness of these programs requires a thorough understanding of the current demographic profile of the profession.

Methods: The American Board of Orthopaedic Surgery (ABOS) is the leading board certification organization for orthopaedic surgeons in the United States. The ABOS began collecting self-reported race/ethnicity and sex/gender data of its examinees and diplomates in 2017. This new data set of ABOS was analyzed to describe both the current demographic profile of orthopaedic surgery and trends over time. Underrepresented minority (URM) was defined as a group that is less well represented in orthopaedic surgery than in US census data and includes female, American Indian or Alaska Native, Black or African American, Hispanic/Latino, and Native Hawaiian or Other Pacific Islander categories.

Results: Of the 21,025 currently practicing ABOS diplomates with time-limited ABOS certificates (issued since 1986), 19,912 (94.7%) provided sex/gender data, and 19,876 (94.5%) provided race/ethnicity data. Approximately 84.78% selected male and 8.43% female. The majority identified as White (73.67%), whereas 16.35% selected a URM race/ethnicity category. There have been significant increases in the proportions of female (odds ratio [OR] = 4.72, 95% confidence interval [CI] = 3.64-6.11, $p < 0.001$) and URM (OR = 2.31, 95% CI = 1.80-2.96, $p < 0.0001$). Diplomates among orthopaedic surgeons attaining ABOS board Diplomates from 1989 to present. Among the subspecialties, pediatric orthopaedics reported the highest percentage of females (30.4%). Spine had both the lowest percentage of females (2.63%) and the highest percentage of URMs (8.97%). Sports had the lowest percentage of URMs at 5.63%.

Conclusion: Orthopaedic surgery in 2023 remains largely White and male. However, there have been promising trends toward diversification of orthopaedic surgery both in terms of gender and race/ethnicity. Specialties within orthopaedics have a wide variety of demographic profiles.

Level of Evidence: Level IV Retrospective Cohort Study. See Instructions for Authors for a complete description of levels of evidence.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSOA/A699).

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Introduction

In recent years, there has been an effort among medical specialties to increase both sex/gender and ethnic/racial diversity. Diversification of providers improves patient care and patient trust in medical professionals while mitigating healthcare disparities and barriers to care among underserved populations[1,2]. Gender and racial disparities in orthopaedic surgery residency are well documented within the literature[3-7]. Demographic disparities among practicing, board-certified orthopaedic surgeons are less well described.

Previous estimates of the demographic breakdown of orthopaedic surgeons have relied on trainee data. In 2016, women constituted approximately half of the medical student population[6], and in 2019, they were a slight majority[8]. Despite their prevalence in medical schools, women account for approximately 18% of orthopaedic surgery residents[9].

Some literature suggests no substantive change in the number of female orthopaedic surgery trainees[10,11], whereas others suggest significant increases over time[12-15]. One study estimated it would take 326 years at the current trajectory to reach gender parity with the 50.8% women reported by US census data[16]. A subsequent study estimated 16 years to reach gender parity with the 36.3% proportion of women in medicine[15]. Other studies have reported women comprising higher percentages of applicants to certain orthopaedic subspecialty fellowships (i.e., 25% of pediatric fellowship applicants in 2016) suggesting an increasing representation of women in that specialty overall[12-14].

Findings in the literature regarding changes over time in racial/ethnic diversity in orthopaedic surgery are similarly varied. Okike et al. reported an increase in underrepresented minority (URM) orthopaedic trainees in the 1990s and 2000s, although at a lower rate than other specialties[17]. Using 2006 to 2015 American Association of Medical Colleges (AAMC) resident data, one study reported the demographic distribution of orthopaedic surgery residents as 12.46% Asian, 4.23% Black, 8.3% other/unknown, 4.5% Hispanic, 0.36%. American Indian/Alaskan Native, and 0.19% Native Hawaiian/Pacific. This same study reported a decrease in minority representation among trainees from 2006 to 2015[11].

Although these data have important implications for the status of orthopaedic training, they represent a relatively small subset of orthopaedic surgeons. The number of orthopaedic surgery residents/fellows per year is substantially smaller than the number of practicing orthopaedic surgeons and does not accurately represent the current demographic profile of the entire specialty.

Other estimates of the demographic breakdown of orthopaedic surgeons have come from professional organizations including the American Academy of Orthopaedic Surgeons (AAOS). The most recently published data comes from the AAOS 2018 census and reports a demographic breakdown of 84.7% Caucasian, 6.7% Asian, 2.2% Hispanic/Latino, 1.9% African American, 2.9% other, 1.2% multiracial, and 0.4% Native American as well as 7.6% female. These data consist of responses from 6,775 people or a 22.5% response rate of the 30,141 contacted. Although these data provide the most complete demographic picture of the specialty to date, the overall applicability is limited by the response rate from members in a voluntary organization[18].

The purpose of this study is to describe sex/gender, ethnic, and racial profiles of board-certified orthopaedic surgeons overall and within individual orthopaedic subspecialties using a newly available data set from the American Board of Orthopaedic Surgery (ABOS). A secondary purpose of this study is to identify how these profiles have changed over the past decades as efforts to promote diversity within orthopaedics have increased.

Materials and Methods

ABOS Data Set

The ABOS is the leading board certification agency for orthopaedic surgeons in the United States. The ABOS data set includes year of certification for each of the 37,807 orthopaedic surgeons who have achieved board certification from 1935 to present. This includes currently certified surgeons, those who are no longer certified, and those who have had their certification revoked. In 2017, the ABOS began soliciting sex/gender and race/ethnicity data from its new applicants and subsequently from its diplomates using web-based longitudinal assessment for recertification. This article represents the first analysis of the newly available ABOS data set and is the most complete data set of orthopaedic surgeon demographic data to date (Fig. 1).

Categorization

Race/ethnicity data categories included American Indian or Alaska Native (AI), Black or African American (AA), Hispanic/Latino (His), Native Hawaiian or Other Pacific Islander (NH), Asian, White, and prefer not to answer (PA). Multiple selections were possible. Gender categories included male (M), female (F), and prefer not to answer.

Subspecialty data were reported based on the presence or absence of a hand or sports subspecialty certificate, subspecialty board examination, and self-identified specialty. If the subspecialty certificate (i.e., sports) differed from the other data (i.e., general ortho), the surgeon was classified under the subspecialty certificate.

URM was defined as a group that is less well represented in orthopaedic surgery than in the most recent US census data (US census). This definition is based on the AAMC's definition of URM[19] and is similar to that used in other studies[11-13,17]. URM groups in this paper include female sex/gender and/or selection of race/ethnicity of American Indian or Alaska Native (AI), Black or African American (AA), Hispanic/Latino (His), Native Hawaiian, or other Pacific Islander (NH).

Current Demographics

The ABOS does not collect data on whether a certified practitioner is still in practice. Other studies have attempted to estimate the average length of an orthopaedic surgeon career[18,20]. Presuming a 34-year average career, we estimated our "currently practicing" orthopaedic surgeons to be anyone in the

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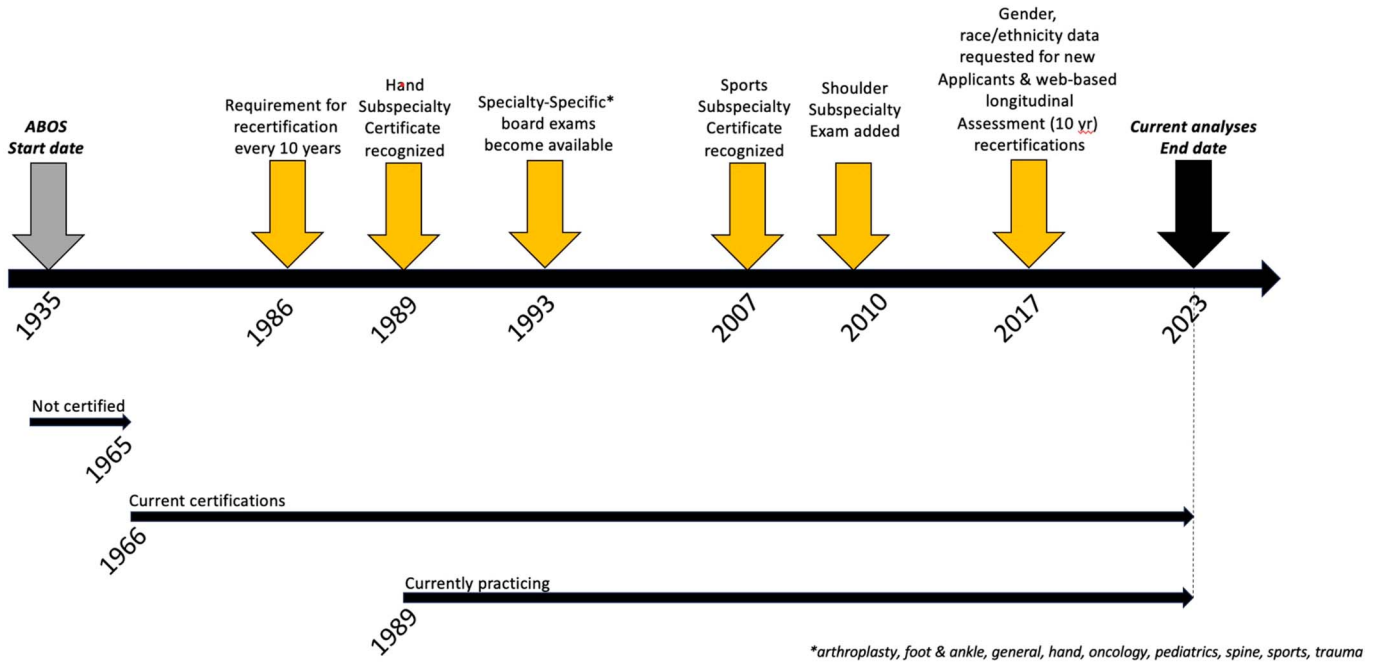

Fig. 1
Timeline of history of board certification events and data collection.

"currently certified" category who attained certification in 1989 or later. The demographic breakdown of currently practicing orthopaedic surgeons was evaluated, both overall and for each subspecialty using race/ethnicity and sex selections. Although the data solicited were categorically labeled as "sex," for the purposes of this study, the terms "sex" and "gender" are used interchangeably. Descriptive statistics were performed, and results were described as frequencies (percentages) overall and by subspecialty. Differences between subspecialties were evaluated with chi-square or Fisher exact tests, as appropriate.

Demographic Trends Over Time

ABOS board-certified surgeons were grouped into 4 cohorts based on their year of initial certification to estimate demographic trends over time: 1989 to 1993, 1999 to 2003, 2009 to 2013, and 2019 to 2023. These cohorts would represent groups that would have certified or recertified in the past 5 years and thus likely still be in practice. Potential trends in gender and race distributions overall and within subspecialties were evaluated with logistic regression, using the 1989 to 1993 cohort as the reference group. In sensitivity analyses, trends were evaluated using the Cochrane-Armitage test for trends using all data from 1989 to 2023 from currently certified surgeons.

All analyses were completed using SAS statistical software version 9.4 (SAS Institute Inc, Cary, NC), and a p value <0.05 was considered significant.

Results

Information regarding 37,807 orthopaedic surgeons is available with initial certification years from 1935 to 2023. Of these, 30,287 are listed as "currently certified," 7,335 are "not certified," and 185 have had their certification "revoked." None of those with initial certifications between 1935 and 1965 are "currently certified."

Of the 30,287 currently certified orthopaedic surgeons, 20,788 (68.6%) provided sex/gender data, and 20,734 (68.5%) provided race/ethnicity data (Table I). The 1985 certification class had a 7.52% response rate for both sex/gender and race/ethnicity data, whereas the 1986 certification class had a 51.82% response rate for sex/gender data and 51.54% response rate for race/ethnicity data. Response rates in later years were high with a >99% response rate from 2017 to 2023 (Fig. 2).

"Currently practicing" orthopaedic surgeons (certified in 1989 or later) comprised 21,025 orthopaedic surgeons. Of these, 19,912 (94.7%) provided sex/gender data, and 19,876 (94.5%) provided race/ethnicity data (Table I).

Currently Practicing

The currently practicing group was 84.78% male and 8.43% female (Fig. 3). The majority identified as White (73.67%), 9.98% identified as Asian, 3.18% as Hispanic/Latino, 3.02% as Black or African American, 0.29% as American Indian or Alaskan Native, and 0.14% as Native Hawaiian/Pacific Islander (Fig. 3). Sex/gender profiles were similar among the different ethnic groups (Fig. 4). A full breakdown of racial/ethnic selections is shown in Table II.

From 1989 to 2023, there was a significant increase in the proportion of women among the orthopaedic surgeons attaining board certification, rising from 3.3% in 1989 to 1993 to 14.0% for 2019 to 2023 (Cochrane-Armitage trend test

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TABLE I Gender Selections of Respondents in the "Currently Certified" and "Currently Practicing" Groups*

Gender of Respondents	Currently Certified (1966-2023)	Currently Practicing (1989-2023)
Male	18,675 (89.8%)	17,826 (89.5%)
Female	1,790 (8.6%)	1,773 (8.9%)
Prefer not to answer	323 (1.56%)	313 (1.57%)
Response rate	20,788 (68.6%)	19,912 (94.7%)

*There were more responses in the "currently practicing" group (94.7%) than the "currently certified" group (68.6%), whereas the demographic profile of the 2 groups was similar.

$p < 0.0001$). When comparing the 2019 to 2023 to 1989 to 1993 5-year cohort, there was a significant increase in the odds of newly board-certified orthopaedic surgeon being female (OR = 4.72, 95% CI = 3.64-6.11, $p < 0.001$) (Fig. 5).

Similarly, from 1989 to 2023, there was a significant increase in the proportion of URM by racial/ethnic category among orthopaedic surgeons attaining board certification, rising from 4.4% to 10.0%, ($p < 0.001$). When comparing 2019 to 2023 with the 1989 to 1993 reference 5-year cohort, there was a significant increase in the odds of a newly board-certified orthopaedic surgeon identifying as URM by race/ethnicity (OR = 2.31, 95% CI = 1.80-2.96, $p < 0.0001$) (Fig. 6).

Subspecialties

The initiation of subspecialty-specific board examinations in 1993 allowed applicants to take a board recertification exam in their self-selected specialty (Fig. 1). Since 1993, there has been a substantial increase in the number of diplomates maintaining board certification and self-identifying under a subspecialty; nearly 50% of diplomates were in the general category in 1993 compared with 12.5% in 2023 ($p < 0.0001$).

Among the subspecialties, peds had the highest percentage of females at 30.4% (249) followed by oncology at 23.6% (52). Spine and arthroplasty had the lowest percentage females at 2.63% (51) and 3.97% (63), respectively. In the case of both general ortho and spine, a higher percentage of people did not respond (8.29%, n = 513 and 5.72%, n = 111, respectively) than selected female sex/gender. Hand had the highest overall number of females at 466 (16.7%) (Table III).

Among the subspecialties, spine had both the largest percentage of URMs by race/ethnicity selection (n = 174, 8.97%) and the largest percentage of prefer not to answer responses (n = 147, 7.58%). Shoulder and oncology had the second and third highest percentages of URMs (n = 21, 8.79% and n = 19, 8.64%), respectively. Sports and hand had the lowest percentages of URMs by race/ethnicity selection at

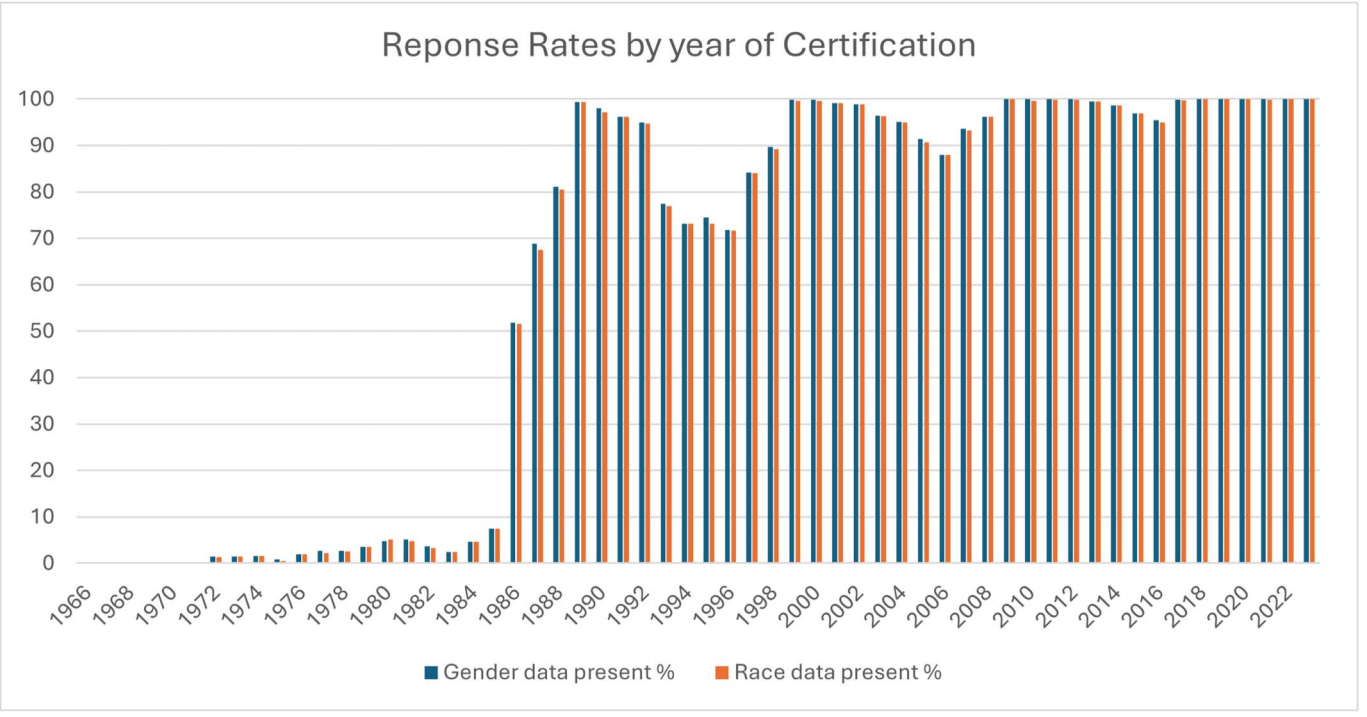

Fig. 2

Response rates for gender data and race/ethnicity data by year of certification. There was 1 response from the 1966 certification class. The 1985 certification class had a 7.52% response rate for both gender and ethnicity data, whereas the 1986 certification class had a 51.82% response rate for gender data and a 51.54% response rate for race/ethnicity data. Response rate in later years remained high with a >99% response rate from 2017 to 2023.

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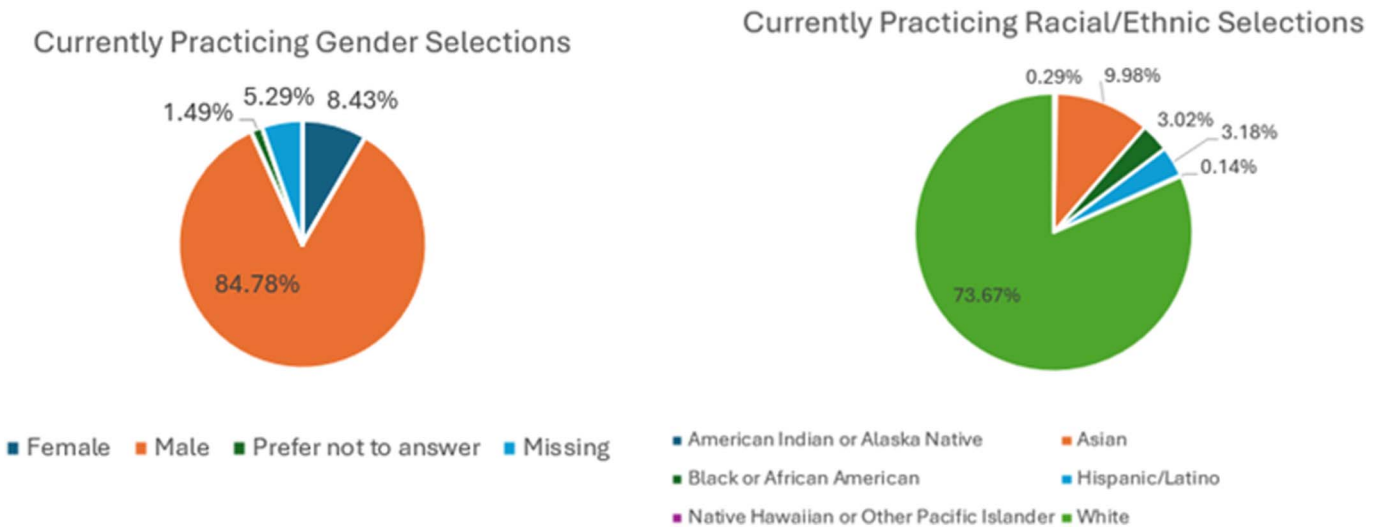

Fig. 3

Gender and racial/ethnic breakdown (percentages) of currently practicing orthopaedic surgeons, N = 21,025.

5.63% (n = 220) and 5.99% (n = 167), respectively. General orthopaedic surgery had the highest overall number of URMs by race/ethnicity at 1,367 (6.5%) but also had the highest no-response rate (8.5%) and prefer not to answer rate (6.14%). URM percentages among the subspecialties were general ortho 6.60%, sports 5.63%, hand 5.99%, spine 8.97%, arthroplasty 6.68%, trauma 7.19%, foot and ankle 6.88%, peds ortho 6.96%, shoulder 8.79%, and oncology 8.64% (see Appendix 1). The racial/ethnic selections among currently practicing orthopaedic specialists are shown in Figure 7 alongside 2020 US census data.

Discussion

We believe these data represent the most comprehensive of the sex/gender and race/ethnicity distribution of orthopaedic surgeons to date. Orthopaedic surgery remains

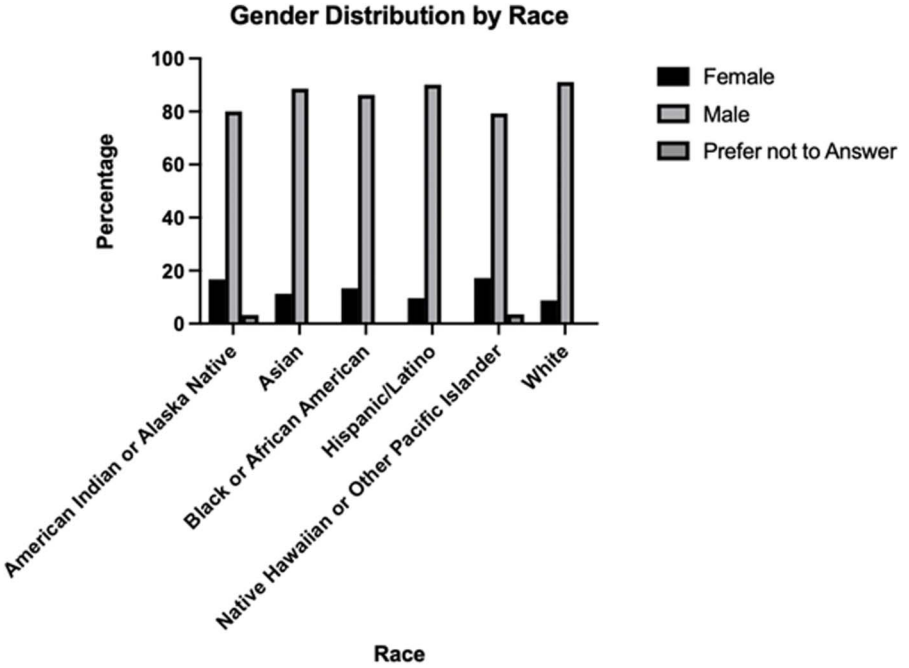

Fig. 4

Gender profile (percentages) within racial/ethnic group selection among currently practicing orthopaedic surgeons. Native Hawaiian/Pacific Islander had the highest female representation at 17.2%, whereas White had the both the highest overall number (15,482) and the lowest female representation at 8.8%.

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TABLE II All Race/Ethnicity Selections Among "Currently Practicing" Including Multiple Category Selections, Listed by Decreasing Frequency

Categories Selected (#)	Race/Ethnicity	Frequency	%
1	White only	15,173	72.17
1	Asian only	1,947	9.26
1	Prefer not to answer only	1,250	5.95
0	No selection	1,152	5.48
1	Black/African American only	579	2.75
1	Hispanic/Latino only	532	2.53
2	Asian and White	112	0.53
2	Hispanic/Latino and White	108	0.51
2	Black/African American and White	30	0.14
2	American Indian/Alaskan Native and White	28	0.13
2	White and prefer not to answer	20	0.1
1	American Indian/Alaskan Native only	19	0.09
1	Native Hawaiian/Pacific Islander only	16	0.08
2	Black/African American and Asian	11	0.05
2	Black/African American and Hispanic/Latino	9	0.04
2	Hispanic/Latino and Asian	7	0.03
2	Asian and prefer not to answer	4	0.02
3	American Indian/Alaskan Native and Hispanic/Latino and White	4	0.02
3	Hispanic/Latino and Asian and White	3	0.01
2	Native Hawaiian/Pacific Islander and White	3	0.01
2	Native Hawaiian/Pacific Islander and Asian	3	0.01
3	Native Hawaiian/Pacific Islander and Asian and White	3	0.01
3	Black/African American and Asian and White	2	0.01
2	American Indian/Alaskan Native and Hispanic/Latino	2	0.01
3	Native Hawaiian/Pacific Islander and Hispanic/Latino and Asian	1	0
2	American Indian/Alaskan Native and Asian	1	0
3	American Indian/Alaskan Native and Asian and White	1	0
4	American Indian/Alaskan Native and Native Hawaiian/Pacific Islander and Asian and White	1	0
3	American Indian/Alaskan Native and Black/African American and White	1	0
2	American Indian/Alaskan Native and Hispanic/Latino	1	0
5	American Indian/Alaskan Native and Black/African American and Native Hawaiian/Pacific Islander and Hispanic Latino and White	1	0
6	American Indian/Alaskan Native and Black/African American and Native Hawaiian/Pacific Islander and Hispanic Latino	1	0
	Total	21,025	100%

predominately male and White with a demographic distribution that does not match the distribution of the US population.

The demographic profiles presented in this study are similar to the AAOS data from the 2018 AAOS census but with a larger proportion in the female and URM categories. This may represent more granular information from the larger number of respondents (19,912 vs. 6,775) or may represent a trend toward increased alignment with the demographic profile of the US census[18]. This study does demonstrate promising trends including increasing numbers of female and URM by race/ethnicity orthopaedic surgeons gaining board certification over the period studied. These changes are likely due to a combination of increased awareness of the importance of diversity and implementation of initiatives aimed at improving diversity.

Pipeline programs aimed at increasing gender diversity (Ruth Jackson Orthopaedic Society [RJOS], Perry Initiative), racial/ethnic diversity, or both (Nth Dimensions, J. Robert Gladden Orthopaedic Society [JRGOS]) have likely contributed to increasing diversity in orthopaedic surgery (Fig. 8). The Perry Initiative aims to increase female exposure to

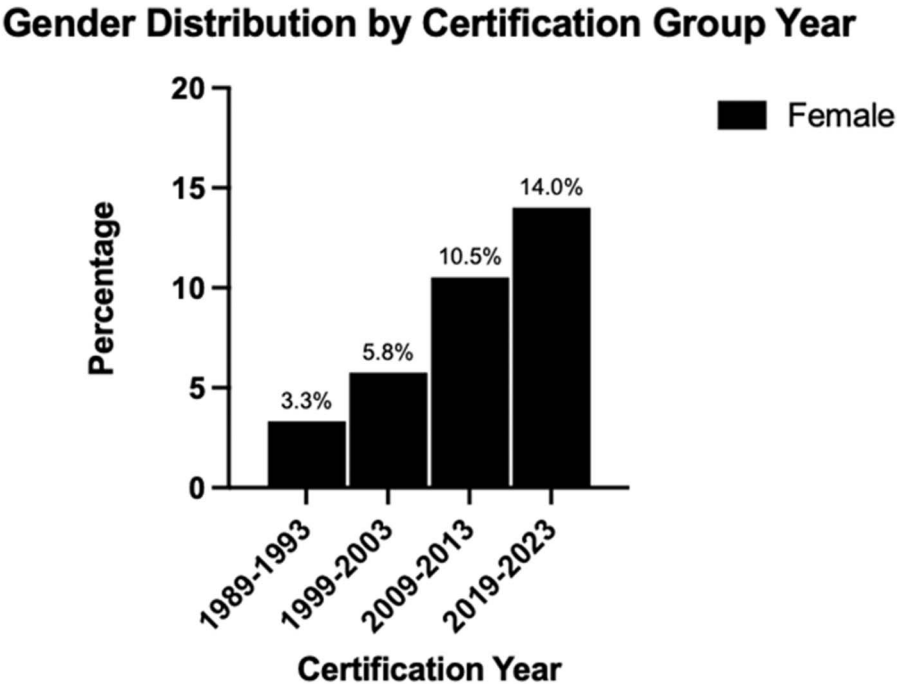

Fig. 5

Gender distribution by year of certification using 5-year cohorts. Compared with the 1989 to 1993 group, there was a significant increase in females becoming board-certified in 1999 to 2003 (OR 1.771, 95% CL 1.325-2.367, p = 0.0001), 2009 to 2013 (OR 3.404, 95% CL 2.602-4.455, p < 0.0001), and 2019 to 2023 (OR 4.715, 95% CL 3.637-6.113, p < 0.0001).

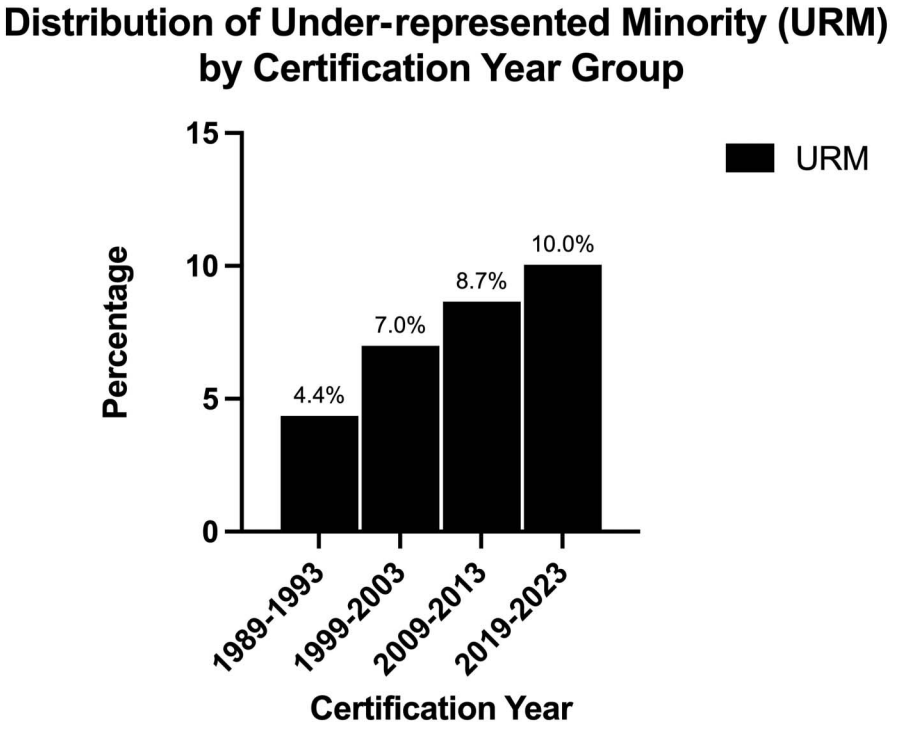

Fig. 6

URM by racial/ethnic selection distribution by year of certification using 5-year cohorts. Compared with the 1989 to 1993 group, there was a significant increase in URMs becoming board-certified in 1999 to 2003 (OR 1.607, 95% CL 1.227-2.104, p = 0.0006), 2009 to 2013 (OR 1.998, 95% CL 1.533-2.577, p < 0.0001), and 2019 to 2023 (OR 2.305, 95% CL 1.796-2.959, p < 0.0001).

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TABLE III All Sex/Gender Ethnicity Selections Among "Currently Practicing" by Subspecialty

	Male	Female	Prefer Not to Answer	No Response	Total
General ortho	5,320 (84.6%)	349 (5.64%)	93 (1.5%)	513 (8.29%)	6,185
Sports	3,454 (88.4%)	236 (6.04%)	61 (1.56%)	158 (4.04%)	3,909
Hand	2,149 (77.1%)	466 (16.7%)	52 (1.87%)	129 (4.84%)	2,787
Spine	1,749 (90.2%)	51 (2.63%)	28 (1.44%)	111 (5.72%)	1,939
Arthroplasty	1,452 (91.6%)	63 (3.97%)	18 (1.13%)	53 (3.34%)	1,586
Trauma	857 (83.3%)	122 (11.8%)	20 (1.94%)	30 (2.92%)	1,029
Foot and ankle	725 (80.5%)	130 (14.4%)	12 (1.33%)	34 (3.77%)	901
Peds	527 (64.4%)	249 (30.4%)	7 (0.85%)	36 (4.4%)	819
Shoulder	212 (88.7%)	22 (9.21%)	4 (1.67%)	1 (0.42%)	239
Oncology	158 (71.8%)	52 (23.6%)	5 (2.27%)	5 (2.27%)	220

orthopaedic surgery and engineering careers both at the high school and medical school levels. One study demonstrated a higher match rate in orthopaedic surgery for program alumnae[21]. Similarly, 80% of female medical student recipients of RJOS scholarships have gone on to practice orthopaedic surgery[22]. The Nth Dimensions program, which is a close partner organization of JRGOS, has a long-standing track record of increasing the number of black, indigenous, and persons of color orthopaedic surgeons. Medical student participants in Nth Dimensions summer internship programs have shown high rates of application and success in matching in orthopaedic surgery[12,13,23].

Substantial changes in the demographics of the practicing population of orthopaedic surgeons will take many years. This study estimates a current population of 21,025 practicing surgeons based on an estimated 34-year career. The 777 newly

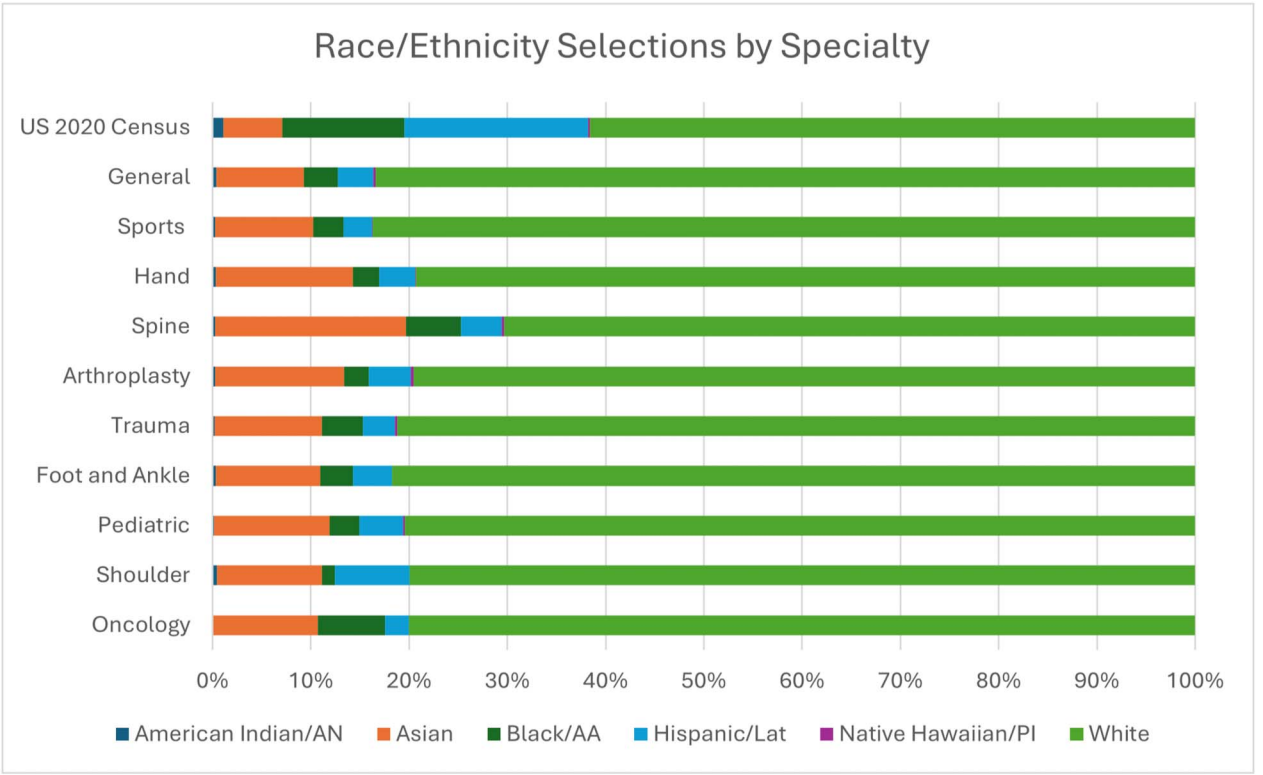

Fig. 7

Stacked bar chart showing race/ethnicity selections of currently practicing orthopaedic surgeons by specialty. There were 42 surgeons with both hand and sports subspecialty certificates and 25 with "other" designations that are not included in this chart. The 1,344 currently practicing orthopaedic surgeons without indicated specialties were excluded. The top bar indicates data taken from the 2020 US census.

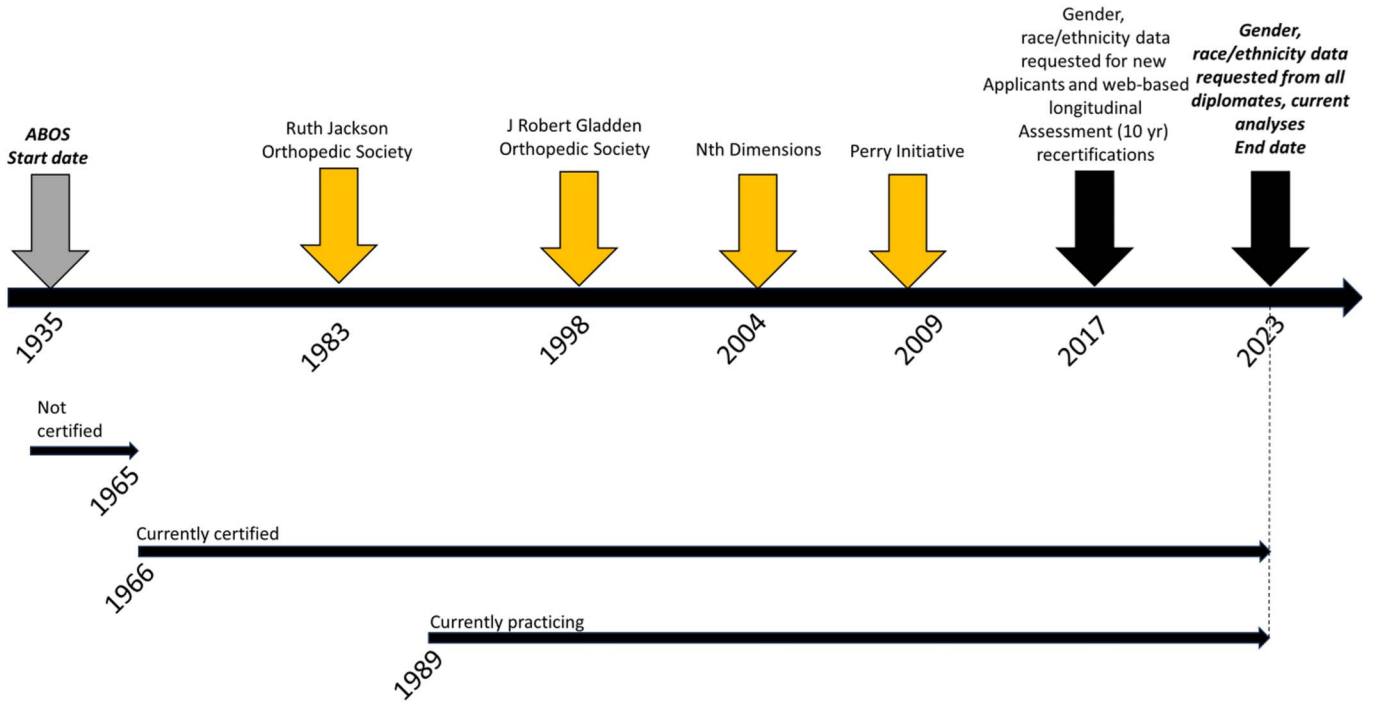

Fig. 8
Timeline showing pipeline program start dates and ABOS data collected.

board-certified orthopaedic surgeons from 2023 would thus account for <4% of the practicing population. A significant increase in sex/gender or racial/ethnic diversity among <4% of a population per year would take many years to significantly change the makeup of the entire population. The data presented in this study will facilitate future studies evaluating the changing demographic profiles of orthopaedic residents and applicants, and aid in predictive modeling. Tracking of trends in trainee demographics will also allow more insight into the effects of the many initiatives in place to improve diversity within the field of orthopaedic surgery.

This study has several limitations. First, these data rely on self-report and voluntary participation in data collection. Second, although board certification is widespread and required for many positions, it is not a requirement to be a practicing orthopaedic surgeon. This study does not capture those who are not ABOS board-certified. Doctors of osteopathic medicine (DOs) are able to achieve board certification through ABOS or through a separate organization, the American Osteopathic Board of Orthopaedic Surgery (AOBOS). Thus, DOs who are not board-certified by ABOS would not be captured in this data set. AAMC data from 2019 reports that DOs make up 1,069 of practicing orthopaedic surgeons[24], making it unlikely that lack of AOBOS data would significantly change the outcomes of this study. In addition, as orthopaedic surgeons do not become ABOS board-certified for 2 to 3 years after completing residency, orthopaedic surgeons currently in their first 2 years of practice are not included.

Third, we have little insight into the "prefer not to answer" group. Given the small numbers in certain categories, some of the findings in this study could be affected by responses provided by that group–i.e., if all of the PA choosers identified as Native Hawaiian/Pacific Islander only, it would increase the number of people in that category by nearly 8,000%. Alternatively, if the PA group identified with the "White" and "male" groups, the resulting percentages would only change by approximately 0.01%. "Prefer not to answer" (only) was the third most common selection when not counting each racial/ethnic category individually (i.e., Table II)

Fourth, the categories used may not capture all respondents. Orthopaedic surgeons who did not see a choice under the sex/gender or race/ethnicity category they feel adequately represents them may have chosen not to respond or chosen an option that does not completely reflect their identity.

Fifth, this study uses sex/gender and race/ethnicity as a metric to evaluate diversity. However, this does not account for all types of diversity. Other types of diversity including cultural, sexual orientation, economic, religious, age, geographic, etc. are not evaluated in this study.

This study will contribute to the body of literature painting the most comprehensive picture of the demographic distribution of currently practicing orthopaedic surgeons. The categories identified as URM for the purposes of this study remain URM based on the results of this study. Although there are trends toward increasing diversity in orthopaedic surgery, there remains a substantial gap between the demographic profile of orthopaedic surgeons and the demographic profile of the patients they treat. This study will hopefully serve as a baseline for comparison for future studies

evaluating the changes in the orthopaedic workforce as well as efficacy of interventions to effect those changes.

Appendix

eA Supporting material provided by the author is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSOA/A698). This content has not been copyedited or verified. ■

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