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# Removing or Only Moving a Barrier? Screening Applications with US Medical Licensing Examination Step 2CK Instead of Step 1 May Benefit Women but Not Underrepresented Minorities in Orthopaedics

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**Background:** Most orthopaedic surgery program directors report using a minimum score cutoff for the US Medical Licensing Examination Step 1 examination when evaluating residency applicants. The transition to a Pass/Fail grading system beginning in the 2022-2023 application cycle will alter applicant evaluation in the interview selection process. The impact of this change, particularly on women and underrepresented minority (URM) applicants, remains unclear. This study was designed to evaluate how a shift to screening applications using Step 2 Clinical Knowledge (CK) instead of Step 1 scores could impact selection for residency interviews.

**Methods:** We reviewed all 855 Electronic Residency Application Service applications submitted to the University of Pennsylvania's orthopaedic surgery residency program in the 2020-2021 cycle. Applicant age, sex, medical school of graduation, self-identified race, and permanent zip code were evaluated for association with Step 1 and Step 2CK scores using a 2-sample *t* test. A multivariable linear regression analysis was conducted to understand the predictive value of demographic features and medical school features on Step 1 and 2CK scores.

**Results:** Multivariable linear regression revealed both Step 1 and 2CK scores were lower for applicants of URM status (Step 1: $p < 0.001$; Step 2CK: $p < 0.001$) and from international medical schools ($p = 0.043$; $p = 0.006$). Step 1 scores but not Step 2CK scores were lower for applicants who were women ($p < 0.001$; $p = 0.730$), ≥30 years of age ($p < 0.001$; $p = 0.079$), and from medical schools outside the top 25 in National Institutes of Health (NIH) funding or *US News and World Report* (*USNWR*) ranking ($p = 0.001$; $p = 0.193$).

**Conclusions:** Conversion of Step 1 grading to Pass/Fail may reduce barriers for groups with lower average Step 1 scores (URM, female, ≥30 years of age, and from institutions with lower NIH funding or *USNWR* rankings). However, if Step 2CK scores replace Step 1 as a screening tool, groups with lower Step 2CK scores, notably URM applicants, may not experience this benefit.

**Level of Evidence:** Level IV. 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/A517).

## Introduction

In the 2021-2022 residency application cycle, orthopaedic surgery residency applicants from US medical schools submitted an average of 90 applications per applicant, higher than any other specialty[1,2]. Increasing applications are likely driven by the competitiveness of the orthopaedic surgery residency application process, given that 35% of applicants from allopathic medical schools did not match into residency positions in 2022[3]. As a result, program directors rely on screening strategies for residency applications[1].

The US Medical Licensing Examination (USMLE) Step 1 examination has historically been used as a tool to screen orthopaedic surgery residency applicants. Recently, 83% of orthopaedic surgery residency program directors reported use of a minimum Step 1 cutoff score in the interview selection process[4]. However, beginning in January 2022, the Step 1 examination converted to a Pass/Fail grading system[1], and surveys of program directors indicate that the Step 2 Clinical Knowledge (CK) examination is likely to become a screening tool when extending invitations for residency interviews[5]. Step 1 scores have previously been shown to be an imperfect screening tool, and the elimination of this variable may shift focus toward factors that are more predictive of later performance as a resident. Unlike Step 1 scores, clerkship grades during medical school and Step 2 scores have been associated with better performance on American Board of Orthopaedic Surgery Part I scores and Orthopaedic In-Training Scores[6]. However, challenges with identifying optimal metrics of residency performance limit these analyses.

Compared with other fields with high USMLE scores, orthopaedics is among the least diverse medical specialties with respect to both sex and racial diversity. Orthopaedic surgery has low rates of women and underrepresented minorities (URMs) applying into the field[7]; in addition, the orthopaedic surgery residency application process itself may limit diversity, given that “objective” measures of a residency application (Step 1 and 2CK scores, letters of recommendation, Alpha Omega Alpha selection, etc.) are prone to bias[8-10]. To the best of our knowledge, the demographic factors associated with a higher Step 1 or Step 2CK score in orthopaedic surgery residency applicants have not been studied nor has the effect of the Step 1 scoring change on women and URMs in the application process.

The purpose of this study is to identify the relationship between Step 1 and 2CK scores and applicant demographics (such as sex, age, race/ethnicity, or medical school of graduation). Although other studies have focused on cultural aspects of orthopaedic surgery that may discourage underrepresented students from applying into the field, we sought to determine whether Step score cutoffs could act as barriers for individuals after they have decided to apply.

## Methods

After institutional review board approval for this study was obtained, all Electronic Residency Application Service applications submitted to the University of Pennsylvania's orthopaedic surgery residency program for the 2020-2021 cycle were reviewed. The following data were obtained: age as of October 1, 2020; self-reported sex (male vs. female); Step 1, Step 2CK, and Step 2 Clinical Skills scores; medical school of graduation; self-identified race; and permanent zip code.

Age was categorized as <30 vs. ≥30 years; sex as man vs. woman; medical school of graduation as US allopathic, US osteopathic, or international; and race/ethnicity as Caucasian/white, African American/black, Asian, Hispanic or Latino, American Indian or Alaskan native, Native Hawaiian or Pacific Islander, or multiethnic if an applicant's described identity included multiple categories. Race/ethnicity was further classified as URMs in medicine (African American/black, Hispanic or Latino, American Indian or Alaskan native, or Native Hawaiian or Pacific Islander) vs. not URM (Caucasian/white or Asian). Medical schools were classified as public, private, or international; as top 25 schools according to the *US News and World Report* (*USNWR*) rankings of medical schools in 2022[11]; as top 25 institutions for research funding in 2021 from the National Institutes of Health (NIH); and as having a home orthopaedic surgery residency program[12].

Data on the race/ethnicity and sex of US medical school graduates (2020-2021) and US medical school enrollees (2021-2022) were obtained from reports by the Association of American Medical Colleges[13]. Race/ethnicity and sex data for the US population were collected from the US Census Bureau[14].

Univariate statistical analyses of differences in mean Step 1 and 2CK scores were performed with 2-sample *t* tests, and analysis of variance for the explanatory variables are listed in Tables I and II. A multivariable linear regression analysis was conducted modeling Step 1 and 2CK scores vs. predictor variables of applicant type: URM status, sex, age, top 25 NIH or *USNWR*, home orthopaedic program, private US medical school, and Step 1 score ≥240. All statistical tests were 2-sided and evaluated at an alpha of 0.05. Statistical analyses were conducted with Microsoft Excel.

Applicants were excluded from zip code analysis if they graduated from an international medical school, if they did not provide a permanent zip code within the United States or Puerto Rico, or if their permanent zip code matched the site of their medical school of graduation. Of 855 applicants, 768 were included in zip code analysis. Zip code 5-year estimates for income and education (2015-2019), and 1-year estimates for poverty rate (2020), were retrieved from the US Census Bureau. Applicants were then categorized in a binary format depending on how their permanent zip code statistics compared with national averages for each of the following variables: population below the poverty line (11.4%), population >25 years of age who graduated high school (88.0%), population >25 years of age holding a bachelor's degree or higher (32.1%), and median household income ($62,843)[14].

Applicants were stratified by race/ethnicity and then evaluated for whether they would meet Step 1 and 2CK score cutoffs. Theoretical cutoffs comprised 10-point differences beginning at 200 and increasing to 240 for Step 1 and 250 for Step 2CK scores given differences in scoring percentiles on the examinations[15]. Applicants who listed multiple identities under race/ethnicity were classified as “multiethnic non-URM” if none of these identities were URMs and “multiethnic URM” if 1 or more listed identities were URMs.

**TABLE I Univariate Analysis of Step 1 and Step 2 Scores**

| | Step 1 Score | | | Step 2 Score | | |
|---|---|---|---|---|---|---|
| | No. (%) | Mean (SD) | p Value | No. (%) | Mean (SD) | p Value |
| Total | 844 (100) | 244.8 (13.3) | — | 759 (100) | 253.1 (12.9) | — |
| Sex | | | <0.001 | | | 0.026 |
| Male | 624 (73) | 246.3 (12.5) | | 556 (72) | 253.8 (12.3) | |
| Female | 228 (27) | 240.4 (14.4) | | 211 (28) | 251.5 (14.1) | |
| Age ≥30 yrs | | | <0.001 | | | <0.001 |
| Yes | 62 (7) | 235.2 (17.9) | | 52 (7) | 244.7 (17.8) | |
| No | 790 (93) | 245.4 (12.6) | | 715 (93) | 253.8 (12.2) | |
| Applicant type | | | 0.002 | | | <0.001 |
| US allopathic | 768 (90) | 245.2 (13.1) | | 689 (90) | 253.8 (12.1) | |
| US osteopathic | 52 (6) | 242.7 (12.7) | | 49 (6) | 249.7 (13.4) | |
| International medical graduate | 32 (4) | 237.1 (17.5) | | 29 (4) | 242.3 (20.6) | |
| Underrepresented minority | | | <0.001 | | | <0.001 |
| Yes | 160 (19) | 237.0 (15.3) | | 139 (19) | 245.0 (13.3) | |
| No | 667 (81) | 246.6 (12.2) | | 606 (81) | 254.9 (12.1) | |
| Home orthopaedic program | | | 0.041 | | | <0.001 |
| Yes | 689 (81) | 245.1 (13.2) | | 617 (80) | 254.0 (12.2) | |
| No | 163 (19) | 242.8 (13.8) | | 150 (20) | 249.5 (14.7) | |
| Top 25 NIH funding | | | 0.018 | | | 0.265 |
| Yes | 146 (17) | 244.3 (14.0) | | 108 (14) | 254.4 (11.7) | |
| No | 706 (83) | 244.2 (13.5) | | 659 (86) | 252.9 (13.0) | |
| Top 25 *USNWR* ranking | | | 0.021 | | | 0.214 |
| Yes | 151 (18) | 247.0 (12.1) | | 114 (15) | 254.5 (11.5) | |
| No | 701 (82) | 244.2 (13.5) | | 653 (85) | 252.9 (13.1) | |
| Private or public US school | | | 0.510 | | | 0.023 |
| Private | 384 (47) | 244.7 (13.0) | | 329 (45) | 252.5 (12.5) | |
| Public | 428 (53) | 245.3 (13.1) | | 402 (55) | 254.6 (12.0) | |
| Step 1 ≥240 | | | | | | <0.001 |
| Yes | — | — | | 539 (70) | 257.9 (9.7) | |
| No | — | — | | 228 (30) | 242.0 (12.4) | |
| Household income <$62,843 | | | 0.652 | | | 0.704 |
| Yes | 341 (44) | 244.7 (13.3) | | 319 (46) | 253.6 (11.8) | |
| No | 431 (56) | 245.2 (13.2) | | 381 (54) | 253.3 (12.8) | |
| Poverty >11.4% | | | 0.584 | | | 0.797 |
| Yes | 403 (52) | 244.7 (13.4) | | 403 (55) | 253.3 (11.9) | |
| No | 369 (48) | 245.2 (13.0) | | 335 (45) | 253.6 (12.9) | |
| High school degree <88.0% | | | 0.914 | | | 0.908 |
| Yes | 270 (35) | 244.7 (13.1) | | 240 (34) | 253.5 (11.8) | |
| No | 502 (65) | 245.1 (13.3) | | 460 (66) | 253.4 (12.7) | |
| Bachelor's degree or higher | | | 0.060 | | | 0.953 |
| <32.1% | 230 (30) | 243.6 (13.0) | | 214 (31) | 253.4 (12.1) | |
| ≥32.1% | 542 (70) | 245.5 (13.2) | | 486 (69) | 253.5 (12.5) | |

NIH = National Institutes of Health, and *USNWR* = *US News and World Report*. Cutoffs for zip code analysis are based on national averages for household income, percentage of the US population under the national poverty line, population >25 years of age who graduated high school, and population >25 years of age holding a bachelor's degree or higher.

**TABLE II Multiple Linear Regression Analysis of USMLE Step 1 and Step 2 Scores**

| | Step 1 Score | | | Step 2 Score | | |
|---|---|---|---|---|---|---|
| | Estimate | Standard Error | p Value | Estimate | Standard Error | p Value |
| Intercept | 249.8 | 1.3 | <0.001 | 244.5 | 1.4 | <0.001 |
| US osteopathic | −2.6 | 1.9 | 0.179 | −2.7 | 1.7 | 0.106 |
| International medical graduate | −5.3 | 2.6 | 0.043 | −6.4 | 2.3 | 0.006 |
| Underrepresented minority | −9.8 | 1.1 | <0.001 | −6.1 | 1.0 | <0.001 |
| Women | −6.4 | 1.0 | <0.001 | 0.3 | 0.9 | 0.730 |
| Age ≥30 yrs | −8.7 | 1.7 | <0.001 | −2.8 | 1.6 | 0.079 |
| Top 25 NIH or *USNWR* | 4.3 | 1.2 | 0.001 | 1.5 | 1.2 | 0.193 |
| Home orthopaedic program | −0.9 | 1.3 | 0.494 | 1.0 | 1.1 | 0.395 |
| Private US medical school | −1.0 | 1.0 | 0.277 | −1.6 | 0.8 | 0.052 |
| Step 1 ≥ 240 | — | — | — | 14.2 | 0.9 | <0.001 |

NIH = National Institutes of Health, USMLE = US Medical Licensing Examination, and *USNWR* = *US News and World Report*.

*Source of Funding*
There was no funding to support this research.

## Results

Data were collected from the 855 applicants to the University of Pennsylvania's orthopaedic surgery residency program for the 2020-2021 cycle. The mean Step 1 and 2CK scores were 244.8 ± 13.3 and 253.1 ± 12.9 (mean ± SD), respectively (Table I). The applicant pool consisted of 768 US allopathic medical school graduates, 52 US osteopathic medical school graduates, and 32 international medical graduates (Table I). The typical applicant was male (73%), <30 years old (93%), and of non-URM status (81%).

Demographic analysis (Fig. 1) demonstrated the greatest difference between men (73.2%) and women (26.8%) in applicants to orthopaedic surgery residency. Of decreasing frequency, the self-described race/ethnicity of applicants was Caucasian/white (60.1%), Asian (18.8%), African American/black (8.3%), multiethnic (7.6%), Hispanic/Latino (4.9%), and native Hawaiian/Pacific Islander (0.2%) (Fig. 1).

Analysis of applicants meeting various Step 1 and 2CK cutoff scores showed that Black and Hispanic applicants were less likely to meet higher score cutoffs compared with White and Asian applicants (Fig. 2). For example, at a Step 1 cutoff score of 230, 91% of white applicants and 68% of black applicants would move to further application consideration. At a Step 2CK cutoff score of 240, 91% of white applicants and 61% of black applicants would move to further application consideration.

Univariate analysis (Table I) showed that Step 1 scores differed significantly based on applicant characteristics. Step 1 scores were lower for women (p < 0.001), applicants ≥30 years of age (p < 0.001), graduates of US osteopathic medical schools and international medical schools (p = 0.002), applicants of URM status (p < 0.001), applicants without a home residency program (p = 0.041), and graduates of institutions outside of the top 25 in NIH funding (p = 0.018) and the *USNWR* (p = 0.021). Of the 766 applicants in the zip code analysis, there was no significant differences in Step 1 scores when comparing across categories of permanent zip code (household income, poverty line, high school degree, and bachelor's degree or higher).

Univariate analysis (Table I) showed fewer statistical differences by applicant type for Step 2CK scores. Step 2CK scores were lower for women (p = 0.026), applicants ≥30 years of age (p < 0.001), those attending US osteopathic medical schools and international medical schools (p < 0.001), and those without an orthopaedic residency program at their institution (p < 0.001). There were no significant differences in Step 2CK scores across URM status, rankings of institutions in NIH funding or the *USNWR*, or categories of permanent zip code.

On multivariable linear regression analysis (Table II) for Step 1 and 2CK scores as response variables, a lower Step 1 score was associated with URM status (β = −9.8, p < 0.001), female sex (β = −6.4, p < 0.001), age ≥30 years (β = −8.7, p < 0.001), and graduation from an international medical school (β = −5.3, p = 0.043). Higher Step 1 scores were associated with applicants from institutions in the top 25 NIH funding or *USNWR* rankings (β = 4.3, p = 0.001). Lower Step 2CK scores were associated with URM status (β = −6.1, p < 0.001) and graduation from an international medical school (β = −6.4, p = 0.006). Predictors of Step 1 scores but not Step 2CK scores were sex (β = 0.3, p = 0.730), age (β = −2.8, p = 0.079), and graduation from institutions in the top 25 NIH funding or *USNWR* rankings (β = 1.5, p = 0.193).

## Discussion

Lack of diversity among orthopaedic surgeons is a persistent problem. Many studies have documented disparities based on characteristics such as race and sex, affecting orthopaedic applicants, residents, practicing surgeons, and leaders in the field[16-18]. The “leaky pipeline” metaphor posits how increasing attrition, failure to progress, or choosing alternate courses

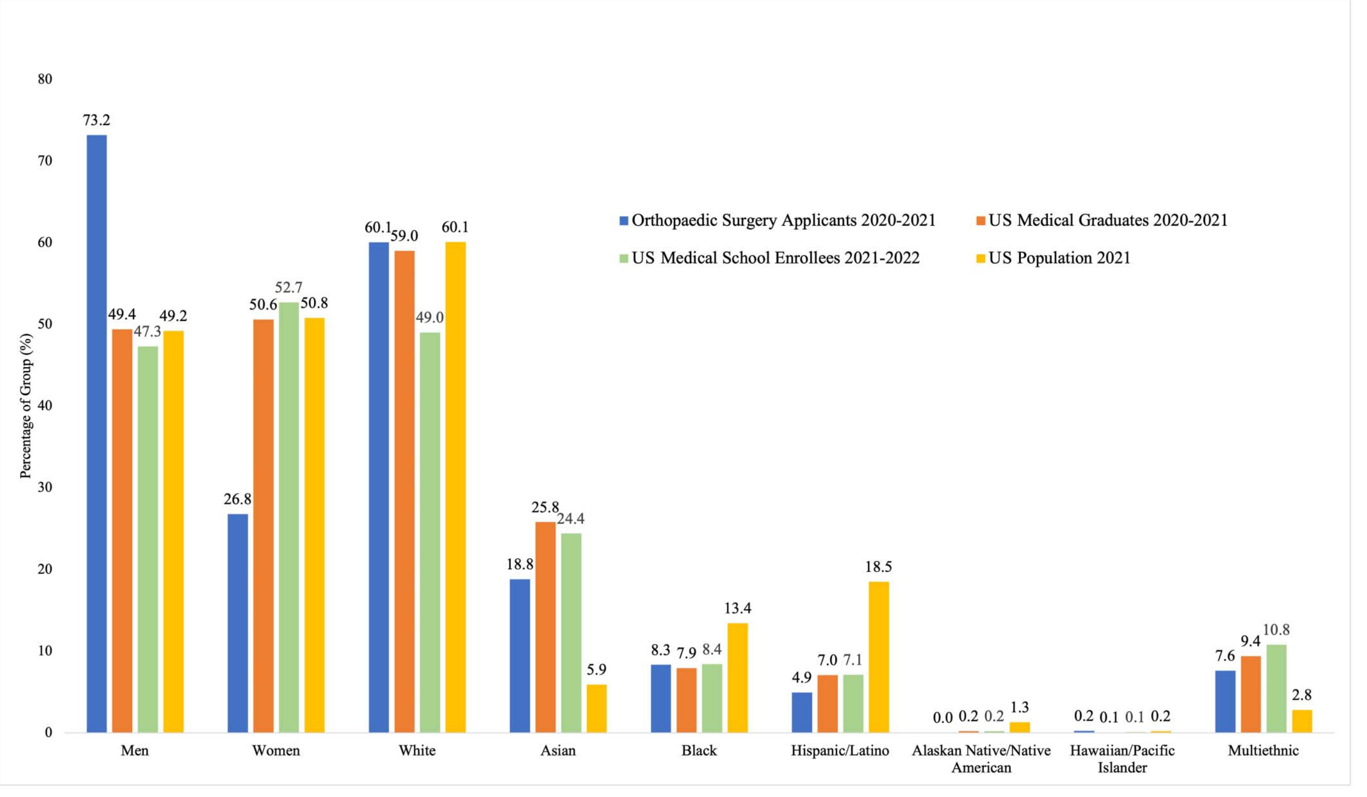


Fig. 1
Percentages of orthopaedic surgery applicants, US medical school graduates, US medical school enrollees, and US population estimates by self-identified sex and race/ethnicity.

results in fewer women at each stage of career advancement[19-21]. Entering the field of orthopaedics from medical school is an early funnel point that leads to an underrepresentation of women further down the pipeline in academic appointments and faculty positions. This study identifies relationships between several aspects of an orthopaedic residency applicant and Step 1 and 2CK scores, key components in determining whether applicants are invited to interview.

When controlling for other aspects of a student's application, we found that women applying into orthopaedics have lower Step 1 scores compared with men, but equivalent Step 2CK scores (Tables I and II). The underrepresentation of women in orthopaedics has been well documented; despite making up 52.7% of medical students nationwide[13], only 18% of orthopaedic residents and 6.5% of practicing orthopaedic surgeons are women[22,23]. When controlling for metrics of academic performance, including Step 1 and 2CK scores, female applicants successfully match into residency programs at similar rates to male applicants[24]. Our findings suggest that relying on Step 2CK scores instead of Step 1 may eliminate fewer women in the screening process; however, the actual effects of this transition are unknown because residency programs are still determining how they will evaluate applications in the absence of Step 1 scores.

We found that, like female sex, URM status predicted lower Step 1 scores; however, URM status also predicted lower Step 2CK scores (Tables I and II). Representation of racial/ethnic minorities in orthopaedics is especially low relative to other surgical subspecialties[7]. The proportion of race/ethnicity applicants to orthopaedic residency is substantially lower than that of medical school graduates, which in turn is lower than that of the US population (Fig. 1). URM applicants also have lower odds of admission to orthopaedics residencies even when controlling for academic performance metrics including Step 1 and 2CK scores[24]. The distribution of applicants who would meet various Step 1 score cutoffs demonstrates how the historical use of Step 1 as a screening tool in orthopaedic surgery may have contributed to the underrepresentation of racial/ethnic minorities in the field (Fig. 2). Based on score distributions, applicants of URM status will continue to be disadvantaged if Step 2CK becomes a new screening tool for residency applicants (Fig. 3).

We observed that higher Step 1 scores were associated with graduation from medical schools higher in the rankings of NIH funding and *USNWR* (Tables I and II). According to reports by the National Resident Matching Program, applicants who successfully matched into orthopaedic residencies were more likely to be graduates of medical schools with greater NIH funding[3]. Step 1 scores and attendance of highly ranked medical schools are likely related. Highly ranked medical schools recruit students with higher Medical College Admission Test scores, who are on average better standardized test takers and likely to achieve higher scores on Step 1.

Our study has several limitations. We examined applicants to only 1 residency program, leading to potential selection

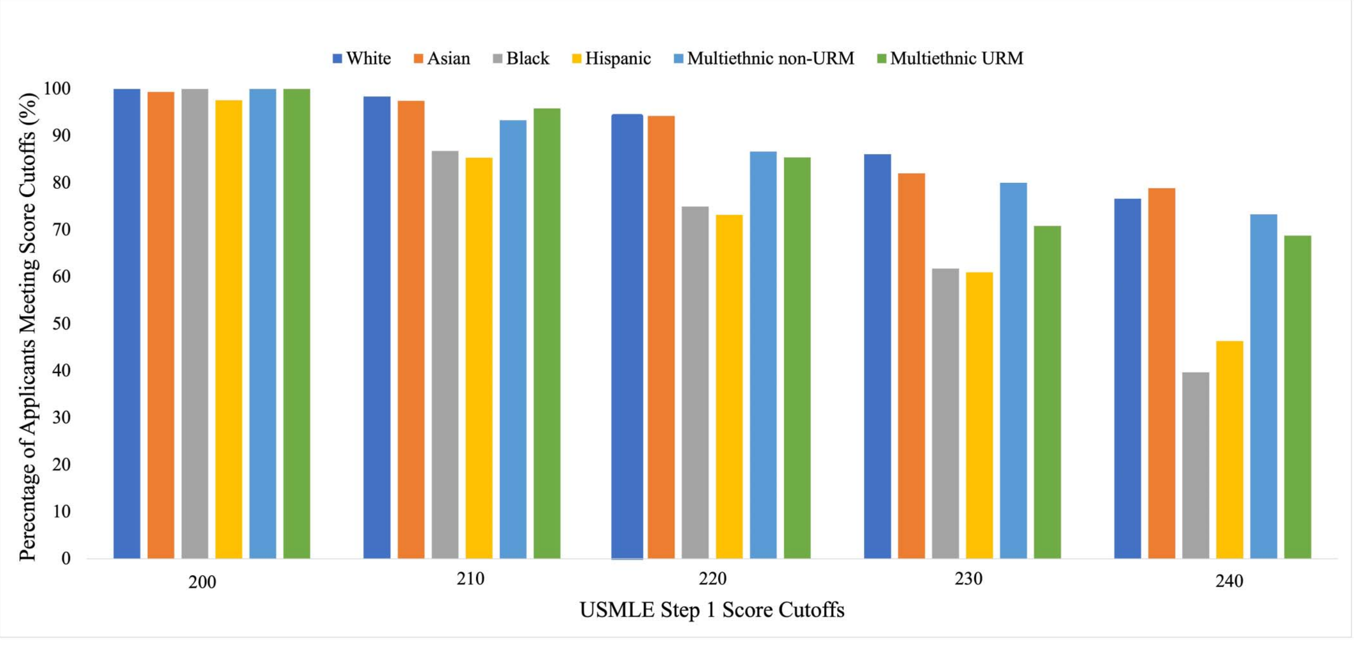


Fig. 2

Percentage of applicants above USMLE Step 1 cutoffs by self-identified race/ethnicity. URM = underrepresented minority, and USMLE = US Medical Licensing Examination.

bias by region or type of program. A multicenter study, including analysis of which applicants were selected for interviews and ultimately matched, would contribute further insight. We also did not analyze every aspect of the residency application, such as research, volunteer experiences, and letters of recommendations; these elements of an application are crucial but difficult to quantify. We are also unable to quantify variable financial or time commitments for different students that would alter time and study resources for USMLE examinations. Another major limitation is our inability to determine

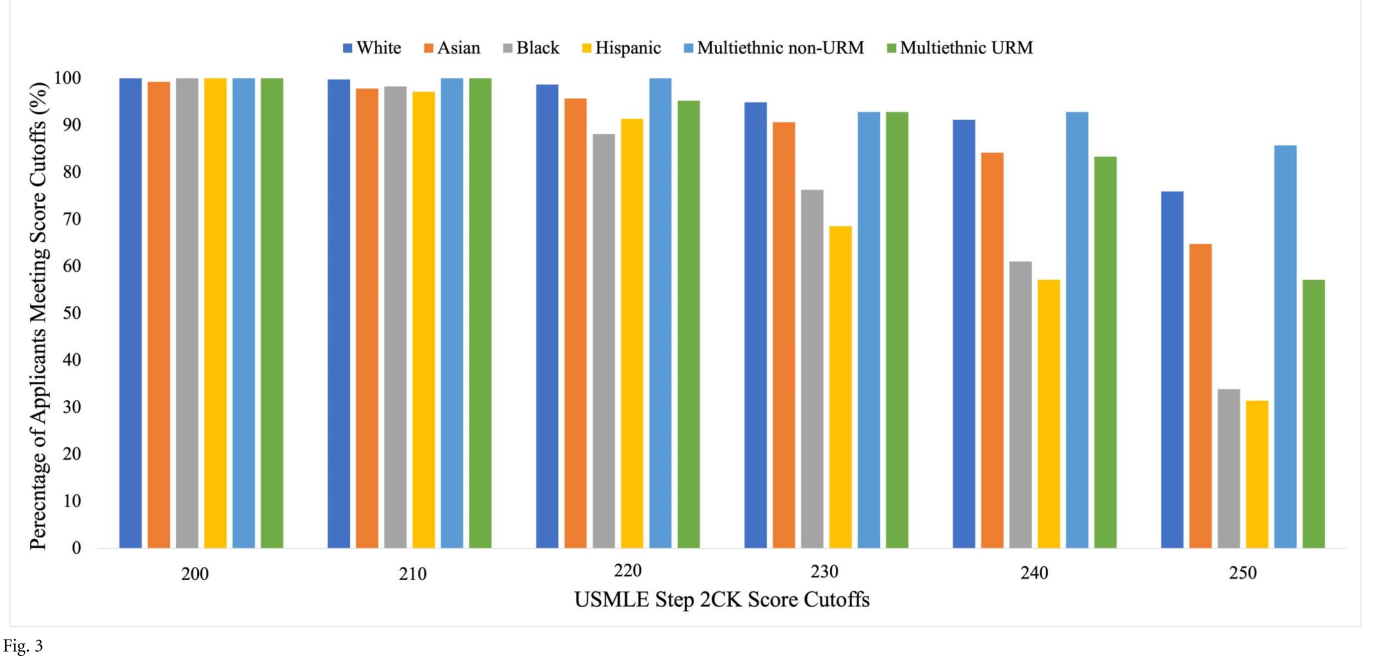


Fig. 3

Percentage of applicants above USMLE Step 2CK cutoffs by self-identified race/ethnicity. CK = Clinical Knowledge, URM = underrepresented minority, and USMLE = US Medical Licensing Examination.

how Step 2CK scores will change in future years. As Step 1 becomes Pass/Fail, the focus may shift heavily toward Step 2CK, and the same groups that previously attained the highest Step 1 scores may remain at the upper end of Step 2CK scores as well. Finally, the gender disparity in orthopaedic surgery applicants is more extreme than other specialties whose applicants have high Step 1 and 2CK scores; for example, residencies in dermatology, integrated plastic surgery, and otolaryngology are composed of 61%, 47%, and 40% women, respectively[23]. This implies that other factors besides Step cutoffs contribute to the lack of gender diversity in orthopaedics. Although several studies have investigated why fewer women choose to pursue careers in orthopaedic surgery, such a discussion is beyond the scope of our study.

Although changing the role of Step 1 in the application process may remove 1 barrier to certain groups, a more comprehensive approach, including intentional efforts from national organizations and individual departments, will be required to improve diversity in orthopaedics. Several valuable programs have been created to attract and retain underrepresented groups in orthopaedics. The Nth Dimension provides opportunities and mentorship for URM students, and the Ruth Jackson Orthopaedic Society aims to support women in the field of orthopaedics at all stages of their careers[25,26]. The American Academy of Orthopaedic Surgeons has focused on increasing diversity in the organization in their Strategic Plan with an emphasis on implicit bias training and monitoring for harassment and discrimination[22]. Several subspecialty organizations have also formed committees to support underrepresented populations, for example, the Women in Arthroplasty Committee and Diversity Advisory Board of the American Association of Hip and Knee Surgeons[27,28]. On an institutional level, creating an inclusive culture can positively influence medical student perceptions of orthopaedics[29,30], thereby attracting a more diverse group of applicants, and is critical to the success and retention of underrepresented groups in the field. A strong commitment from departmental leadership and willingness to prioritize these important issues is needed to foster an environment in which diverse individuals feel valued and are positioned to succeed.

## Conclusions

Historically, residency programs have relied on Step 1 scores as a screening tool to manage the review process of overwhelming numbers of applications. These programs will soon be limited to the Step 2CK examination as the only standardized numerical score by which to screen large numbers of applicants. Although we do not condone the use of screening tools before holistic review of applicants, we recognize that program directors may continue use of screening tools as means to manage the sheer volume of applications. If the patterns we observed persist, this change will potentially lead to more interview opportunities for applicants who are female, older, or from institutions outside the top 25 in NIH funding or *USNWR* rankings. Groups such as URMs and graduates of nonallopathic medical schools may not see the same benefit, and we recommend continuing to pursue strategies to increase diversity of all types in the field of orthopaedics. ■

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