

Ethnic and Sex Diversity in Academic Orthopaedic Surgery: A Cross-sectional Study

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ABSTRACT

Introduction: Although the diversity in orthopaedic residency programs has been studied, the diversity within academic orthopaedics has not.

Methods: The board of specialty societies, five leading journals and the National Institutes of Health RePORTER tool, and three accreditation organizations were explored.

Results: The board of directors comprised 220 (72%) Caucasians, 36 (12%) Asians, 4 (1%) Hispanic/Latinos, 29 (9%) African Americans, and 18 (6%) Other individuals; 250 (81%) were men, and 57 (19%) were women. The editorial boards comprised 288 (77%) Caucasians, 62 (16%) Asians, 14 (4%) Hispanic/Latinos, 8 (2%) African Americans, and 4 (1%) Other individuals; 341 (91%) were men, and 35 (9%) were women. The National Institutes of Health grant recipients comprised 117 (64%) Caucasians, 58 (32%) Asians, 4 (2%) Hispanic/Latinos, and 3 (2%) African Americans; 128 (70%) were men, and 54 (30%) were women. On average, Caucasians, Asians, Hispanic/Latinos, and African Americans received \$776,543, \$439,600, \$420,182, and \$494,049, respectively. On average, men and women received \$759,426 and \$419,518, respectively. The accreditation boards comprised 45 (82%) Caucasians, 6 (11%) Asians, and 4 (7%) African Americans; 45 (82%) were men, and 10 (18%) were women.

Conclusions: Academic orthopaedic surgery does not resemble the United States. Residency, fellowship committees, and professional organization boards need to become aware of these disparities.

Diversity can be defined as the differences in people based on race, spoken language, culture, sex, perspectives, roles, and experiences.¹ Both racial/ethnic diversity and sex diversity have been shown to play an important role in both the professional success of orthopaedic research² and the quality of patient care in orthopaedics.³ However, it is well established that diversity in orthopaedic surgery is far behind that in other medical specialties.^{2,3}

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None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Mr. Vij, Dr. Singleton, Dr. Bisht, Dr. Lucio, Dr. Poon, and Dr. Belthur.

JAAOS Glob Res Rev 2022;6:

DOI: 10.5435/JAOSGlobal-D-21-00321

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Sex and racial/ethnic diversity is lacking as a whole in orthopaedics. The 2019 Census from the US Bureau⁴ reports the percentages of 70.2% Caucasian, 5.7% Asian, 18.4% Hispanic/Latino, 12.8% African American, 0.9% Native American, and 50.8% women. However, the 2018 American Academy of Orthopaedic Surgeons (AAOS) Census⁵ reports 84.7% Caucasian, 6.7% Asian, 2.2% Hispanic/Latino, 1.9% African Americans, 0.4% Native American, and 7.6% women.

Sex and racial/ethnic diversity are lacking in residency programs,⁶ fellowship programs,⁷ and fellowship faculty.⁸ Day et al¹ demonstrate that orthopaedic residencies have the poorest sex diversity prevalence and growth compared with other surgical specialties. Poon et al⁶ showed that the proportion of women among orthopaedic surgery residents was below all specialties except urology. They also demonstrated that representation of African Americans and Asian Americans has not significantly changed between 2006 and 2015. Regarding fellowships, Poon et al⁷ demonstrated that between 2006 and 2015, ethnic diversity among orthopaedic fellows did not increase over time. Thus, orthopaedic surgery residencies and fellowships are lacking in racial and sex diversity and also failing to make significant improvement compared with other specialties.^{1,6}

The diversity and inclusion in leadership roles in orthopaedic surgery with regard to the professional, research, and accreditation domains has not been extensively studied. Ramirez et al³ began to shed light on some of the shortcomings regarding diversity in orthopaedic surgery. This study demonstrates that racial/ethnic diversity is poor in the professional domain through an in-depth look at the American Academy of Orthopaedic Surgeons and also poor in the accreditation domain through an in-depth look at the Accreditation Council for Graduate Medical Education (ACGME).³

The purpose of this research article is to describe the sex and racial/ethnic diversity in the leadership within the professional, research, and accreditation domains of academic orthopaedic surgery and to compare the diversity within academic orthopaedic surgery to that of the US population and the field of orthopaedic surgery. The professional domain was studied using the board of directors of the specialty societies listed on the board of specialty of the AAOS. We expand on research conducted by Ramirez et al to include both racial and sex data from 22 societies. The research domain was studied through the editorial boards of the five leading American orthopaedic journals and National Institutes of Health (NIH) grant funding for orthopaedic research. The

accreditation domain is explored through the American Board of Orthopaedic Surgery (ABOS), the American Orthopaedic Association (AOA), and the Orthopaedic Surgery subset of the ACGME. We also investigated some of the barriers that minoritized groups face in academic orthopaedic surgery and methods for overcoming these barriers.

Methods

This study was determined by the University of Arizona Institutional Review Board as Not Human Subjects Research as defined by 45 CFR 46.102(e). This was a cross-sectional study, and data collection was performed on June 15, 2020. The methodology closely followed a previously published article by Nakayama et al⁹ regarding Asian American Diversity in Academic Surgery.

Surgeons were classified as Caucasian, Asian, Hispanic/Latino, African American, Other, Multiracial, or Native American as performed in the 2018 AAOS Census report.⁵ This was done based on the surgeon's surname and picture as presented on the website for the professional, research, or accreditation website. Surgeons were also classified as men and women based on the forename and picture. This was done independently by three of the authors. Any discrepancies were discussed until an agreement was reached. Other variables collected included leadership position, years held, NIH funding (if received), funding source, and funding amount. Social media posting or any other search results from nonprofessional affiliations were not included.

The racial/ethnic and sex diversity with regard to the professional domain of academic orthopaedic surgery was explored through analysis of the leading American orthopaedic surgical societies. We visited the websites of the board of directors of the specialty societies listed on the board of specialty of the AAOS (Supplemental Table 1, <http://links.lww.com/JG9/A190>) on June 15, 2020. The variables collected included the name, sex, officer positions held (if held), and years held (if available).

The editorial boards of the leading orthopaedic journals (Table 1) and recipients of NIH grants within the last complete fiscal year (2019) were examined to gather data for the research domain of academic orthopaedic surgery. We visited the websites of the editorial boards of the leading five orthopaedic journals, as defined by impact factor. The variables collected included sex and race/ethnicity. The candidates receiving NIH grant data for orthopaedic research were also studied. The data were collected using the NIH RePORTER tool. The fields were

Table 1. The Five Leading Orthopedic Journals by Impact Factor and the Websites for their Editorial Boards

Journal	Impact Factor	Editorial Board Website
<i>American Journal of Sports Medicine</i>	5.673	https://journals.sagepub.com/editorial-board/AJS
<i>The Journal of Bone and Joint Surgery—American</i>	4.840	https://journals.lww.com/jbjsjournal/pages/editorialboard.aspx
<i>Osteoarthritis and Cartilage</i>	4.742	https://www.journals.elsevier.com/osteoarthritis-and-cartilage/editorial-board
<i>Arthroscopy</i>	4.292	https://www.arthroscopyjournal.org/content/edboard
<i>Clinical Orthopaedics and Related Research</i>	3.897	https://journals.lww.com/clinorthop/pages/editorialboard.aspx

entered as Department Type: Orthopaedics, Fiscal Year: 2019, and all other fields were left blank. This query yielded 257 results. The variables collected included name, sex, race/ethnicity, highest degree received, funding source, and the amount received.

The ABOS, the AOA, and the Orthopaedic Surgery subset of the ACGME websites with regards to the accreditation domain of academic orthopaedic surgery (Table 2). We searched the websites of the executive committees of these organizations. The variables collected were the surname, sex, officer positions held (if held), and years held (if available).

After the collection of these data, the sex and racial/ethnic compositions were calculated for each domain of academic orthopaedic surgery. Differences between our data and both the 2019 Census from the US Bureau⁴ and the 2018 AAOS Census⁵ data were taken. Regarding the NIH data, the average dollar amount received per race/ethnicity and sex was calculated. The composition of highest degree attained was also calculated.

Results

Ethnic and Sex Composition Within the Domains of Academic Orthopaedic Surgery

There were a total of 307 individuals on the board of directors for the professional societies within the board of specialty societies. Of these, 220 (72%) were Caucasian, 36 (12%) were Asian, 4 (1%) were Hispanic/Latino, 29 (9%) were African American, 0 were Native American, and 18 (6%) were categorized as ‘Other’ (Figure 1). Of these 307 individuals, 250 (81%) were men, and 57 (19%) were women (Figure 2).

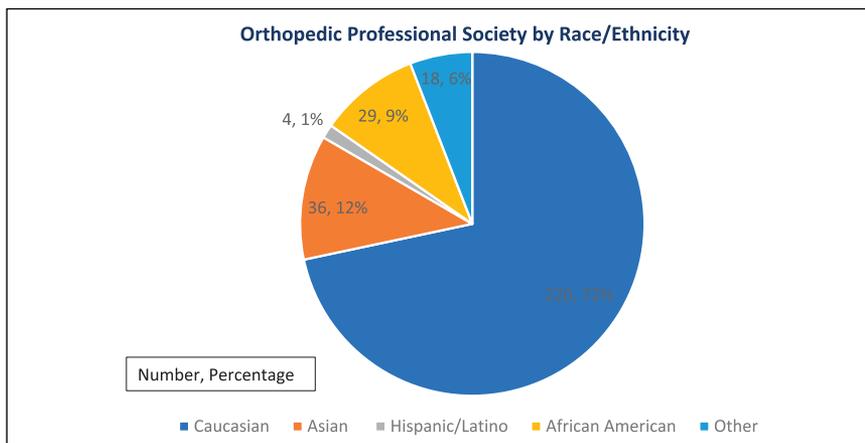
There were a total of 376 individuals within the editorial boards of the 5 leading orthopaedic journals. Of these, 288 (77%) were Caucasian, 62 (16%) were Asian, 14 (4%) were Hispanic/Latino, 8 (2%) were African American, 0 were Native American, and 4 (1%) were categorized as ‘Other’ (Figure 3). Of these 376 individuals, 341 (91%) were men, and 35 (9%) were women (Figure 4).

There were a total of 182 NIH grant recipients according to the NIH Reporter Tool in the fiscal year of

Table 2. The Accreditation Boards Within Academic Orthopaedic Surgery, the Number of Board Members, and the Board of Directors’ Websites

Other Specialty Society	No. on Board	Board of Directors Website
American Board of Orthopaedic Surgery	6	https://www.abos.org/about/board-of-directors/
American Orthopaedic Association	20	https://www.aoassn.org/aoaimis/AOANEW/About/Executive_Committee/AOANEW/About_AOA/Executive_Committee.aspx?hkey=6eebb8b3-fdb8-4092-8680-a10aca153635
Accreditation Council for Graduate Medical Education—Orthopaedic Surgery	14	https://www.acgme.org/Specialties/Review-Committee-Members/pfcatid/14/Orthopaedic%20Surgery

Figure 1



Pie chart showing race/ethnicity of the orthopaedic professional societies listed on the board of specialties under the American Academy of Orthopaedic Surgeons. No data were available for Native American individuals.

2019. Of these, 117 (64%) were Caucasian, 58 (32%) were Asian, 4 (2%) were Hispanic/Latino, 3 (2%) were African American, and 0 were Native American (Figure 5). Of these 182 individuals, 128 (70%) and 54 (30%) were men and women, respectively (Figure 6).

Of the 182 NIH Grant recipients in the 2019 fiscal year, the highest degree attained was as follows: 117 (64%) PhD, 42 (23%) MD, 21 (11%) MD and PhD, 1 (1%) DO, and 1 (1%) ScD (Figure 7). The NIH grant data revealed that the average amount received for a man was notably higher than that for a woman. On average, each man received \$759,426, whereas each woman received \$419,518. The NIH grant data also revealed that the average dollar amount received for Caucasians, Asians, Hispanic/Latino, and African Americans individuals was

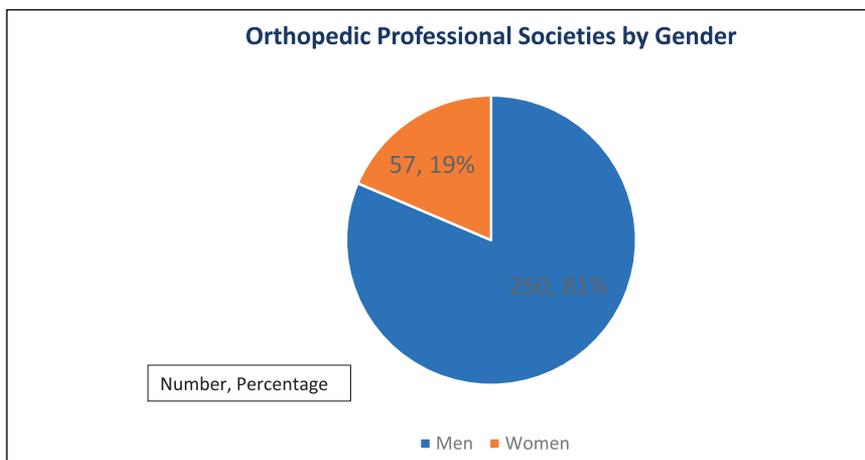
\$776,543, \$439,600, \$420,182, and \$494,049, respectively (Figure 8).

There were a total of 55 individuals on the accreditation boards studied. Of these, 45 (82%) were Caucasian, 6 (11%) were Asian, and 4 (7%) were African American (Figure 9). Of these 55 individuals, 45 (82%) and 10 (18%) were men and women, respectively (Figure 10).

Comparison of Academic Domains to US Bureau Census and American Academy of Orthopaedic Surgeons Census

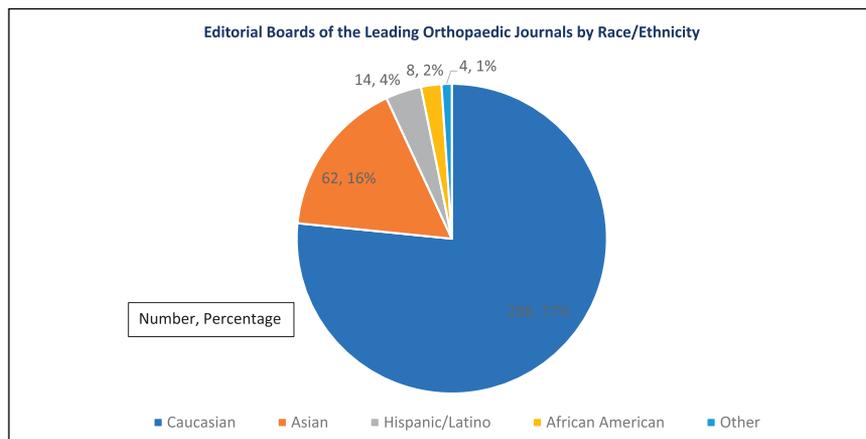
Differences in frequencies of race/ethnicity between a given domain and the 2019 US Bureau Census⁴ revealed differences of 1.8%, 6.8%, -6.2%, and 11.8% (Caucasian); 6.3%, 10.3%, 26.3%, and 5.3% (Asian);

Figure 2



Pie chart showing the sex distribution of the orthopaedic professional societies listed on the board of specialties under the American Academy of Orthopaedic Surgeons.

Figure 3



Pie chart showing race/ethnicity of the editorial boards of the five orthopaedic journals with the highest impact factor. No data were available for Native American individuals.

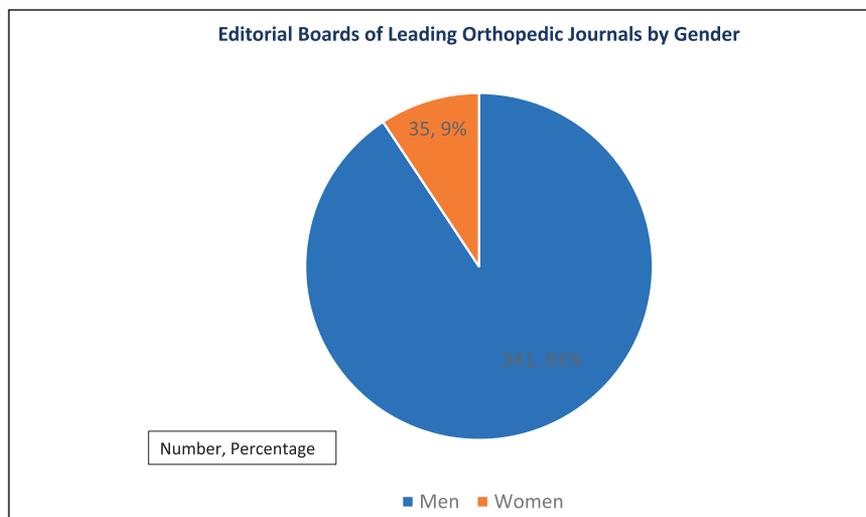
–17.4%, –14.4%, –16.4%, and –18.4% (Hispanic/Latino); –3.8%, –10.8%, –10.8%, and –5.8% (African American); and –0.9%, –0.9%, –0.9%, and –0.9% (Native American) with regard to the board of directors of the professional societies, the editorial boards of the five leading journals, the NIH grant recipients, and the accreditation boards, respectively (Supplemental Table 2, <http://links.lww.com/JG9/A191>).

Differences in frequencies of race/ethnicity between a given domain and the 2018 AAOS Census⁵ data revealed differences of –12.7%, –7.7%, –20.7%, and –2.7% (Caucasian); 5.3%, 9.3%, 25.3%, and 4.3% (Asian); –1.2%, 1.8%, –0.2%, and –2.2% (Hispanic/Latino); 7.1%, 0.1%, 0.1%, and 5.1% (African American);

and –0.4%, –0.4%, –0.4%, and –0.4% (Native American) with regard to the board of directors of the professional societies, the editorial boards of the five leading journals, the NIH grant recipients, and the accreditation boards, respectively (Supplemental Table 3, <http://links.lww.com/JG9/A192>).

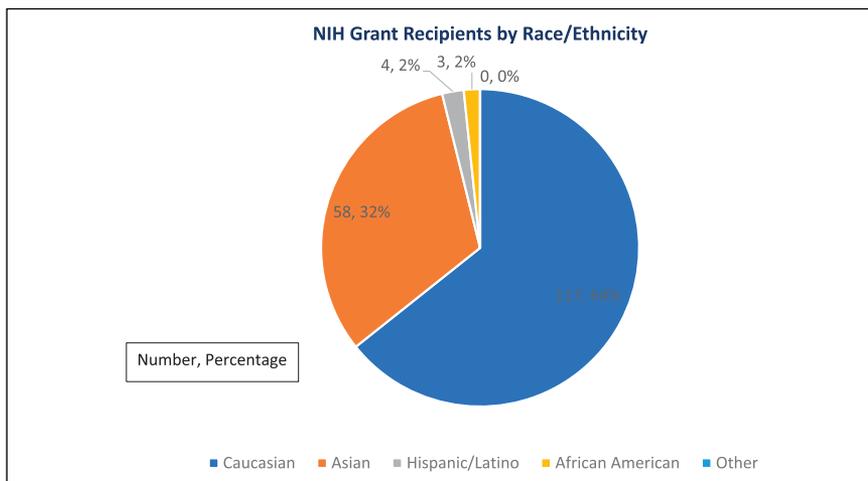
Differences in frequencies of women in a given domain and the 2019 US Bureau Census⁴ revealed differences of –31.8%, –41.8%, –20.8%, and –32.8% for the board of directors of the professional societies, the editorial boards of the five leading journals, the NIH grant recipients, and the accreditation boards, respectively (Supplemental Table 4, <http://links.lww.com/JG9/A193>).

Figure 4



Pie chart showing the sex distribution of the editorial boards of the five orthopaedic journals with the highest impact factor.

Figure 5



Pie chart showing race/ethnicity of the NIH grant recipients during the 2019 fiscal year. No data were available for Native American individuals. NIH = National Institutes of Health.

Differences in frequencies of women in a given domain and the 2018 AAOS Census⁵ data revealed differences of 11.4%, 1.4%, 22.4%, and 10.4% with regard to the board of directors of the professional societies, the editorial boards of the five leading journals, the NIH grant recipients, and the accreditation boards, respectively (Supplemental Table 5, <http://links.lww.com/JG9/A194>).

Discussion

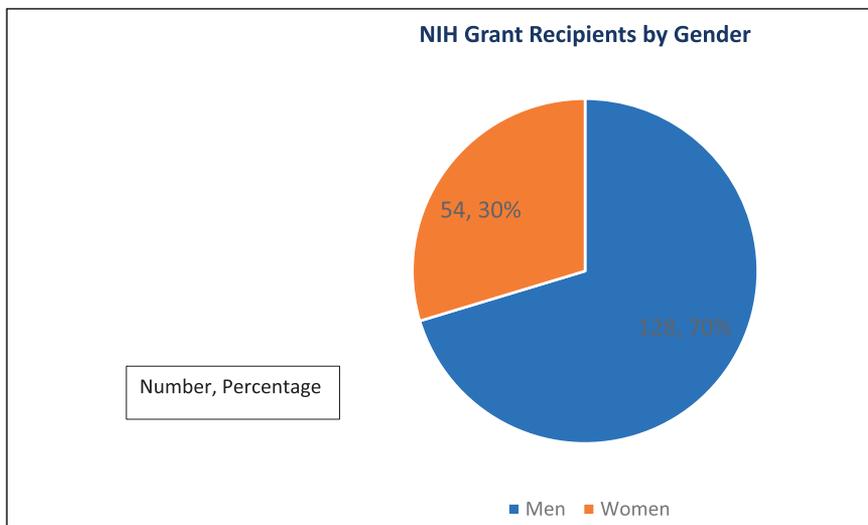
Our results demonstrate that the diversity in academic orthopaedic surgery does not proportionally represent the population of the United States. This held true

regarding both the racial/ethnic and sex diversity in all domains of academic orthopaedic surgery studied.

Racial/Ethnic Diversity

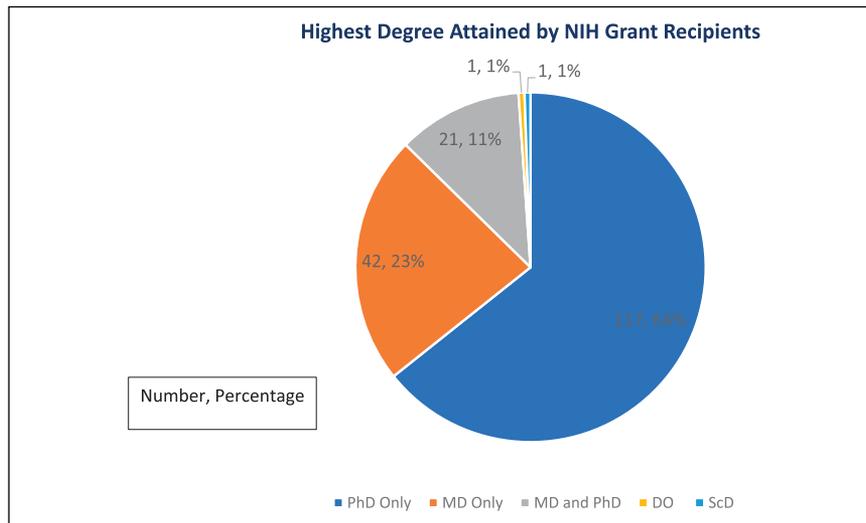
Regarding racial/ethnic diversity, misrepresentation was seen in the professional societies, orthopaedic journals, NIH grant recipients, and accreditation boards. Comparing our results with that from the 2019 Census data from the US Bureau⁴ (Figure 11), one can note that Caucasians were adequately represented in all domains in academic orthopaedic surgery. Although there is some underrepresentation and overrepresentation for NIH grant funding and the accreditation boards,

Figure 6



Pie chart showing the sex distribution of the NIH grant recipients during the 2019 fiscal year. NIH = National Institutes of Health.

Figure 7

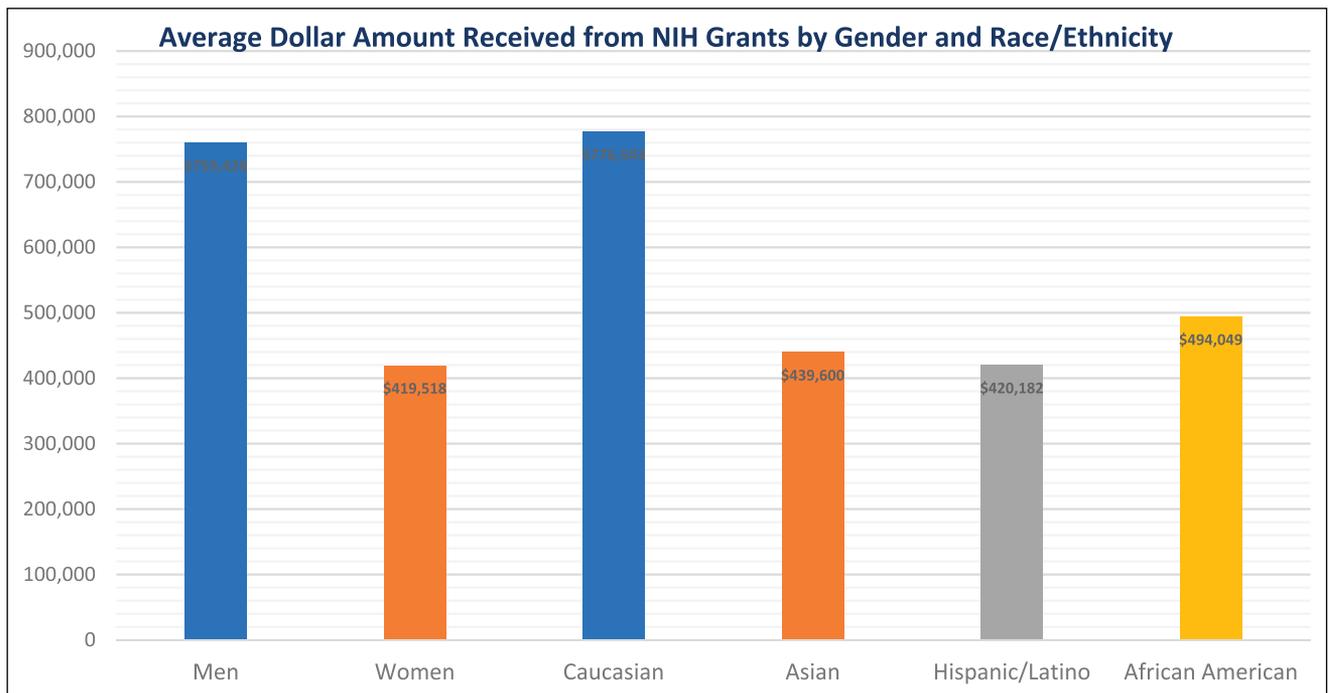


Pie chart showing the highest degree attained by the NIH grant recipients during the 2019 fiscal year. NIH = National Institutes of Health.

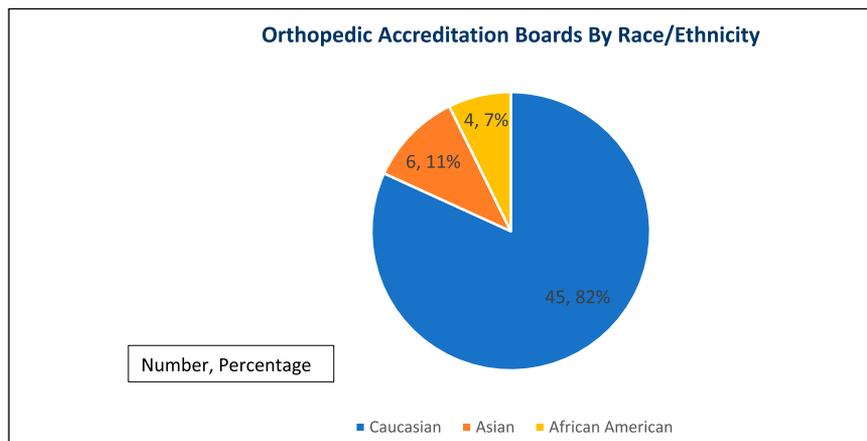
respectively, these figures are well estimated by the US Bureau in terms of percent error. Asian Americans were overrepresented in all domains in academic orthopaedic surgery. Hispanic/Latino individuals are by far the most underrepresented in all fields of academic orthopaedic surgery with the highest proportion (4%) in editorial boards, as compared to that reported by the US Census

Bureau⁴ (18.4%). Not a single individual on the accreditation boards studied (ABOS, AOA, and the Orthopaedic Surgery subset of the ACGME) was Hispanic/Latino. African Americans are also markedly underrepresented in all domains of academic orthopaedic surgery. This underrepresentation is demonstrated across the entirety of the research domain—both with regard to

Figure 8



Bar graph showing the average dollar amount received by men, women, Caucasians, Asians, Hispanic/Latino, and African American individuals from the NIH for orthopaedic related research. No data were available for Native American individuals. NIH = National Institutes of Health.

Figure 9

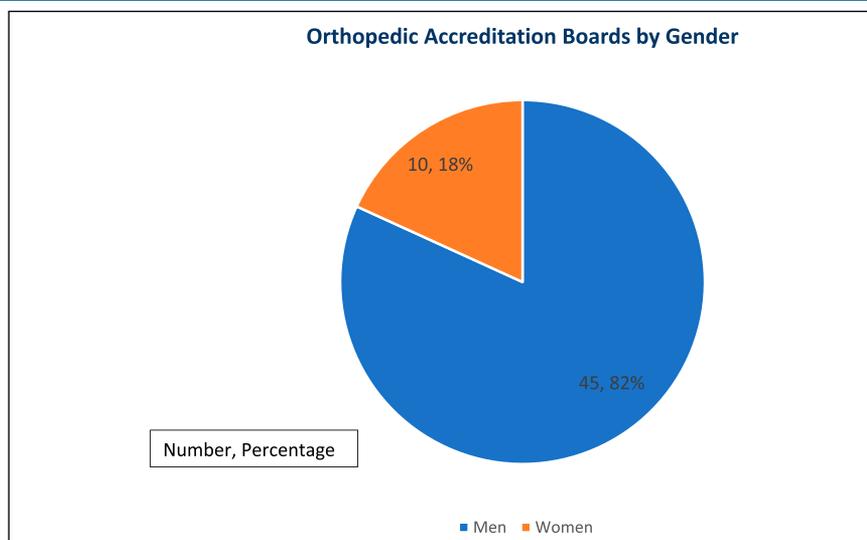
Pie chart showing race/ethnicity of three leading orthopaedic accreditation boards. No data were available for Hispanic/Latino individuals or Native American individuals.

the editorial boards of leading orthopaedic journals and NIH grant recipients. Comparison of our results with the 2019 US Bureau Census⁴ ultimately demonstrates that as a whole, academic orthopaedic surgery fails to represent the population which it serves (Supplemental Table 2, <http://links.lww.com/JG9/A191>, and Figure 11).

The 2018 AAOS Census⁵ presumably represents the profession of orthopaedics and serves as another baseline to compare our results (Supplemental Table 3, <http://links.lww.com/JG9/A192>, and Figure 11). Although Caucasians are proportionally represented in the leadership of professional orthopaedic societies, they are overrepresented in orthopaedic surgery as a whole, and Asian Americans are overrepresented. Hispanic/Latino individuals are

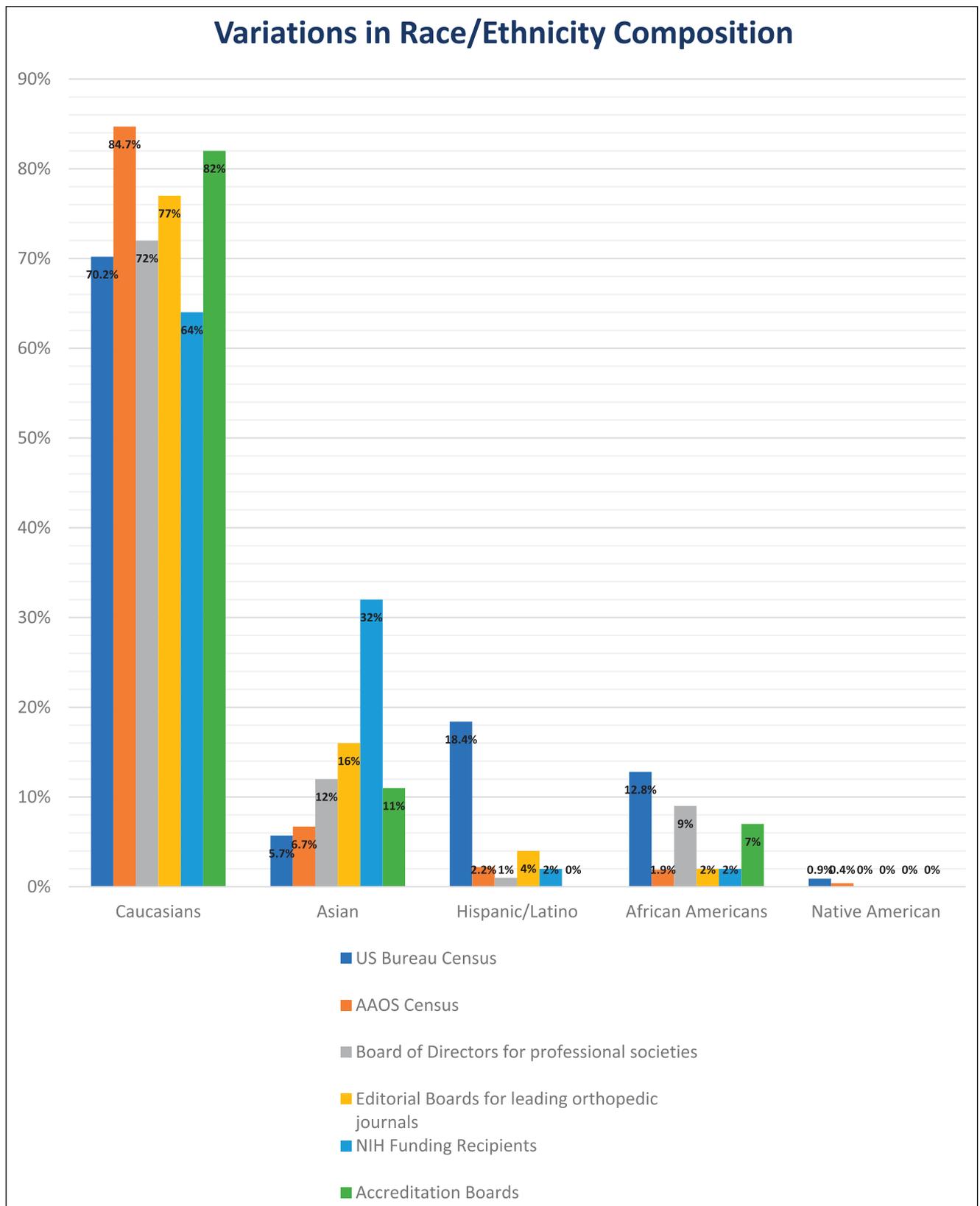
underrepresented in the professional societies and accreditation boards, which points to the several levels of barriers to success in academic orthopaedic surgery faced by Hispanic/Latino individuals. African Americans, compared with the AAOS Census data, are slightly overrepresented in the professional societies and accreditation boards, which implies that other causes of the underrepresentation (matriculation into medical school and matriculation into orthopaedic residency) may play a role.

Another important set of statistics that our data reveals is the average dollar amount of NIH grant data for orthopaedic-related research received by various racial/ethnic groups. Our analysis of the NIH grant data revealed that on average, Asian Americans, Hispanic/Latino, and African

Figure 10

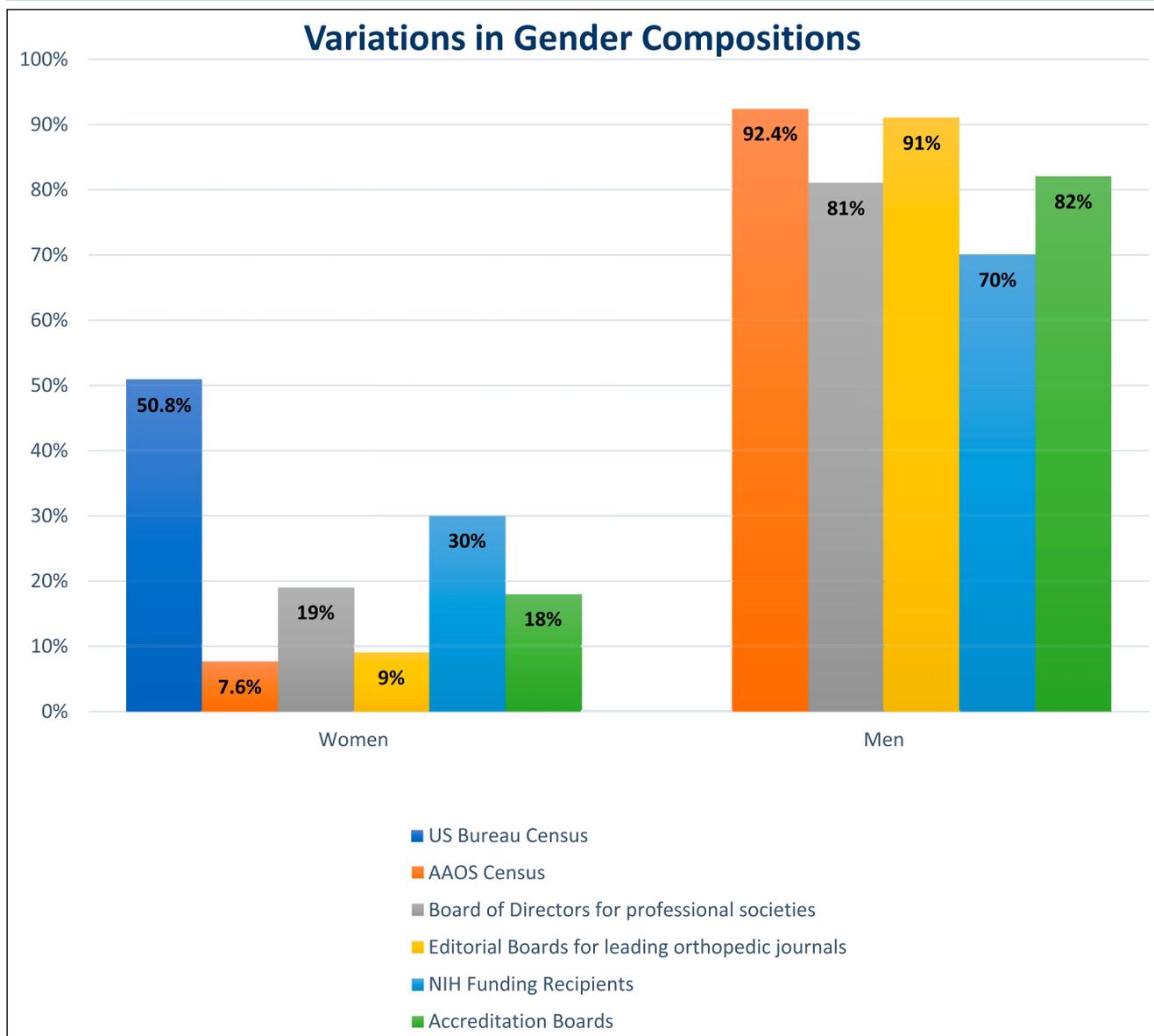
Pie chart showing the sex distribution of the leading orthopaedic accreditation boards.

Figure 11



Bar graph showing race/ethnicity composition comparison between the 2018 US Bureau Census, 2018 AAOS Census, and domains of Academic Orthopaedic Surgery. AAOS = American Academy of Orthopaedic Surgeons, NIH = National Institutes of Health.

Figure 12



Bar graph showing sex composition comparison between the 2018 US Bureau Census, 2018 AAOS Census, and domains of Academic Orthopaedic Surgery. AAOS = American Academy of Orthopaedic Surgeons, NIH = National Institutes of Health.

Americans received significantly less than Caucasians per grant recipient for orthopaedic-related research. On average, Asian Americans (\$439,600) received 56.7% of what the average Caucasian (\$776,543) recipient received. This indicates that although Asian Americans may not necessarily face the same barriers that other minoritized groups face in academic orthopaedic surgery, they do still receive less funding in the research domain.

Hispanic/Latino and African American individuals also received relatively lower funding amounts than the average Caucasian recipient received (\$494,049 and \$420,182, respectively.) This corresponded to 63.6% and

54.1%, of what the average Caucasian recipient received. Thus, African Americans and Hispanics/Latinos face a similar financial barrier regarding research in addition to the aforementioned underrepresentation.

Sex Diversity

Comparing our results with that from the US Bureau Census data⁴ (Supplemental Table 4, <http://links.lww.com/JG9/A193>, and Figure 12), women were highly underrepresented in academic orthopaedic surgery. This stark underrepresentation of women pervaded through all domains of academic orthopaedic surgery.

The 2018 AAOS Census⁵ also demonstrated a significant misrepresentation of women in orthopaedics, with only 7.6% of responders being women. Although our results confirm this significant underrepresentation of women, they also demonstrate that women in orthopaedic surgery may be more inclined toward progression through the domains of academic surgery (see Supplemental Table 5, <http://links.lww.com/JG9/A194>, and Figure 12). This was especially true with regard to the professional societies and accreditation boards.

Although the NIH data did also reveal an underrepresentation of women as compared to the US Census data, it is noteworthy that these values (30% women) are the closest out of any of the domains of academic orthopaedic surgery (ie, professional, research, and accreditation). This likely reflects the several measures in place to ensure a fair evaluation of each NIH Grants & Funding application. These include a blinded peer review process, the designation of a Scientific Review Officer whose responsibility it is to ensure an objective and fair peer review, and an objective 9-point scoring system, which is conducted by several reviewers independently in both a preliminary stage and a final stage. Considering the inherent objectivity of this process, the disparities regarding NIH funding likely do not represent a flaw in the process, but rather other professional barriers to a career in orthopaedic research.¹⁰

Our results also demonstrated that women received significantly less funding from the NIH for orthopaedic-related research, per recipient, than men. Women received 55.2% of what men received when averaged across overall recipients. This further highlights the barriers that women face to participation in academic orthopaedic surgery, specifically in research.

Several other studies have also determined that there is an underrepresentation of women in various aspects of orthopaedic surgery, including residencies and fellowships.^{1,6,11} An important organization is the Ruth Jackson Orthopaedic Society.¹² This predominantly female organization is an example of efforts that have been made to address this issue. However, the results of our study indicate that 37 years after the Ruth Jackson Orthopaedic Society was founded, women are still severely underrepresented in the field of orthopaedics. Day et al¹ demonstrated that although the percentage of women in orthopaedics is growing over time, it is doing so at a considerably slower rate than other specialties. Further change is needed to address the sex disparities highlighted by our study.

Of note in this discussion is the orthopaedic research society (ORS). Alliston et al demonstrated that the ORS

ranked third among orthopaedic societies in women membership, with 24.7% of its members being women. This is significantly higher than the 5.8% reported in the 2018 AAOS census. By leading the orthopaedic societies in terms of sex diversity, the ORS has helped to establish a precedent that may positively affect other orthopaedic specialty societies.²

Limitations

There are several limitations to our study. First, the study represents a cross section of the demographics of leadership in academic orthopaedic surgery at the current time. Thus, we are not able to draw any conclusions regarding how the racial/ethnic and sex diversity in academic orthopaedic surgery has progressed. Our study is limited to racial/ethnic and sex diversity and is not able to explore any forms of intersectionality. We are also limited by the accuracy of the websites searched. As our study relied on all publicly available online information (ie, editorial board websites, NIH grant data, and accreditation board websites), any inaccuracies in these sites would be translated to our raw data. Furthermore, the racial/ethnic and sex composition of these organizations change as re-elections occur, and thus, our data may have slight inaccuracies if websites have not been appropriately updated. Finally, there is some inherent possibility regarding the misidentification of race/ethnicity and sex when considering our methodology. This may have resulted in the underrepresentation of race/ethnicity for which names are less recognizable by western authors. Using gender binary classifications excludes and/or allows for the misidentification of transgender, gender nonconforming, or gender nonbinary identifying individuals.

Conclusions

Academic orthopaedic surgery remains a field dominated by men and Caucasians at this time. Although Asian Americans are well represented in all three domains of academic orthopaedic surgery, Hispanic/Latino and African Americans remain underrepresented in all three domains in academic orthopaedic surgery. In terms of sex, the largest disparities were seen in the editorial boards of the leading orthopaedic journals; however, stark sex disparities were also seen in the professional societies and accreditation boards. Women were best represented in terms of NIH recipients; however, this too was only at 30%. As orthopaedic surgery continues to progress as a field, more conversation and efforts aimed

at addressing these disparities are needed. Residencies, fellowship committees, and the professional, research, and accreditation domains of academic orthopaedic surgery need to become aware of these disparities to implement a more inclusive culture that will result in increased recruitment and support of diverse individuals and thus promote further advancement.

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