



## AOA Critical Issues in Education

# A 25-Year Analysis of Diversity, Equity, and Inclusion Research in Orthopaedics Shows Majority Female Authorship and Increasing Gender Parity Research

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**Introduction:** Orthopaedic surgery is one of the least diverse fields in medicine. In recent decades, there has been a concerted effort to increase diversity, equity, and inclusion (DEI) in the specialty, in addition to the institution of several organizations to establish the pipeline and facilitate underrepresented minority students into orthopaedic surgery. The aim of this study was to examine trends in orthopaedic surgery DEI research.

**Methods:** A search of DEI articles was conducted in orthopaedic surgery using PubMed, MEDLINE, EMBASE, Scopus, Cumulative Index to Nursing and Allied Health Literature, and Education Resources Information Center. The year of publication, article topic of focus, sex of the primary author, publishing journal, citation index, and primary contributing institution were recorded for each article. Sex of the primary author was predicted by the authors using an online image search of the author and institution. Articles were excluded if the research was conducted outside of the United States or if they were not specific to orthopaedic surgery.

**Results:** A total of 143 articles met the inclusion criteria. A total of 52.4% of authors (n = 75) were women and 44.1% (n = 63) were men. A total of 42.7% of the articles were written about sex (n = 61), 39.9% about race/ethnicity and sex (n = 57), and 11.9% about race/ethnicity (n = 17). A total of 10 articles were affiliated with Washington University in St. Louis while 51 other institutions wrote the remaining articles, with none having more than 4. Information could not be confirmed for 5 articles. In 2018, 5 articles were published, followed by 17 in 2019, 25 in 2020, 34 in 2021, and 30 in 2022.

**Conclusion:** DEI research in orthopaedic surgery is a relatively new venture within the specialty and has room to grow, specifically in the examination of race/ethnicity and inclusion strategies. Leading journals and academic institutions in orthopaedic surgery should incentivize productivity and authorship in DEI research.

**Level of Evidence:** III.

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## Introduction

Diversity, equity, and inclusion (DEI) in orthopaedic surgery has been slow to progress<sup>1</sup>. Although diversity in ethnicity and race has also increased among medical students over the past 20 years, minority representation among orthopaedic residents has lagged behind<sup>2</sup>. From 2006 to 2015, total minority representation averaged 25.6%, with an increase in residents of Hispanic origin, a decrease in Native Hawaiian/Pacific Islander residents, and, most drastically, no significant changes in African American representation<sup>2</sup>. Similar results can also be seen with the representation of women. Data from the American Association of Medical Colleges found that the percentage of women in medical schools increased from 0.6% in 1970 to 9.0% in 2001 and has most recently been reported at 51%<sup>1,2</sup>. However, this trend has not been as dramatic for women matching into orthopaedic residency programs, where orthopaedic surgery only had an increase of 27.3% from 2005 to 2017<sup>3</sup>.

Trends in DEI orthopaedic research publications can help with understanding the trajectory of diversity in this field. Compared with research on racial diversity, the literature is more robust concerning sex, where studies have demonstrated that women are not represented equally as authors or editors in the field<sup>4-9</sup>. Although there are far more men than women in orthopaedic surgery, studies have shown that women orthopaedic surgeons enter academic medicine at a greater rate than men<sup>6</sup>. Slight progress can be measured with the increase in women first authors in the high-impact orthopaedic journals of *Clinical Orthopaedics and Related Research (CORR)*, the *Journal of Bone and Joint Surgery (JBJS)*, and the *American Journal of Sports Medicine*, where the percent of first authors increased from 11% in 2006 to 17% in 2017<sup>6</sup>. Furthermore, the total women representation of editorial board members of *JBJS*, *CORR*, and *Journal of the American Academy of Orthopaedic Surgeons (JAAOS)* increased from 3% in 1997 to 9% in 2017<sup>6</sup>.

With years of effort to improve DEI in orthopaedic surgery through strategic initiatives and pipeline programs, an evaluation of DEI literature in the field is not yet reported. The aim of our study was to assess the characteristics of published literature regarding DEI in orthopaedics to identify research gaps that exist, specifically by examining chronologic trends in volume and authorship, as well as the DEI topics of focus.

## Methods

### Study Identification and Inclusion

A search was conducted for DEI articles in orthopaedic surgery using PubMed, MEDLINE, EMBASE, Scopus, Cumulative Index to Nursing and Allied Health Literature, and Education Resources Information Center. We performed the search using the key terms orthopaedic surgery, diversity, inclusion, and equity on November 12, 2022. The inclusion criteria required that reports be published from December 31, 1998, to December 31, 2022; reports be published in English; and that the articles include the evaluation of disparities in race/ethnicity, sex, and other minoritized groups in orthopaedics.

### Study Procedures

The primary screening of titles and abstracts was performed by 2 independent reviewers (D.O. and A.Z.) to determine relevancy. Full-text and reference screening were performed independently by 3 authors (D.O., A.Z., and V.M.), and disagreements were resolved by consensus. The exclusion criteria included (1) data exclusively before 1998; (2) topics unrelated to orthopaedic surgery diversity, equity, and inclusion; (3) articles produced outside of the United States; (4) partial or complete duplicate data; and (5) commentaries or conference abstracts. The variables were not predefined before the qualitative review because one of the goals was to determine the available data in the current literature. Data were compiled after an initial qualitative review, including journal of publication, year of publication, sex of the primary author, primary contributing institution, article topic of focus, and citation index, and suggested methods for DEI improvement were recorded for each article. Sex of the primary author was determined by the pronouns used by the author in their academic or institutional biography profile online.

### Study Outcomes

There were 2 primary study outcomes: (1) characteristics and trends in DEI research within orthopaedic surgery and (2) topics of focus in DEI orthopaedic research.

### Statistical Analysis

The primary outcome was identifying characteristics associated with authoring orthopaedic DEI studies and articles. Author characteristics were compared using the  $\chi^2$  test and *t* test for categorical and continuous variables, respectively. Subanalysis was performed by examining the articles published before the start of 2016 vs. those published after the start of 2016. Binary logistic regression analysis determined the likelihood of female authorship and topic of interest after the start of 2016. In all testing, significance was established a priori for odds ratios and 95% confidence intervals (CIs) exclusive of 1.0 and  $p < 0.05$ . All statistical analyses were conducted using SPSS, version 28.1.1. Descriptive statistics were used to summarize the data as total numbers, percentages, and mean with SD or median with range. Analysis was performed using Microsoft Excel. The number of DEI publications produced was also compared with the overall production of all 36 evaluated journals over a 10-year period using Microsoft Excel.

## Results

### Journal Evaluation

Thirty-six journals that included relevant orthopaedic surgery DEI publications were identified. Of the 36 journals, there were 143 articles over 25 years that met the inclusion criteria (Fig. 1). Three journals provided 60.8% of all DEI orthopaedic publications ( $n = 87$ ). *CORR* produced the most publications focused on DEI ( $n = 45$ , 31.5%), followed by the *JBJS* ( $n = 25$ , 17.5%) and *JAAOS* ( $n = 17$ , 11.9%).

## Number of DEI Articles Published by each Journal

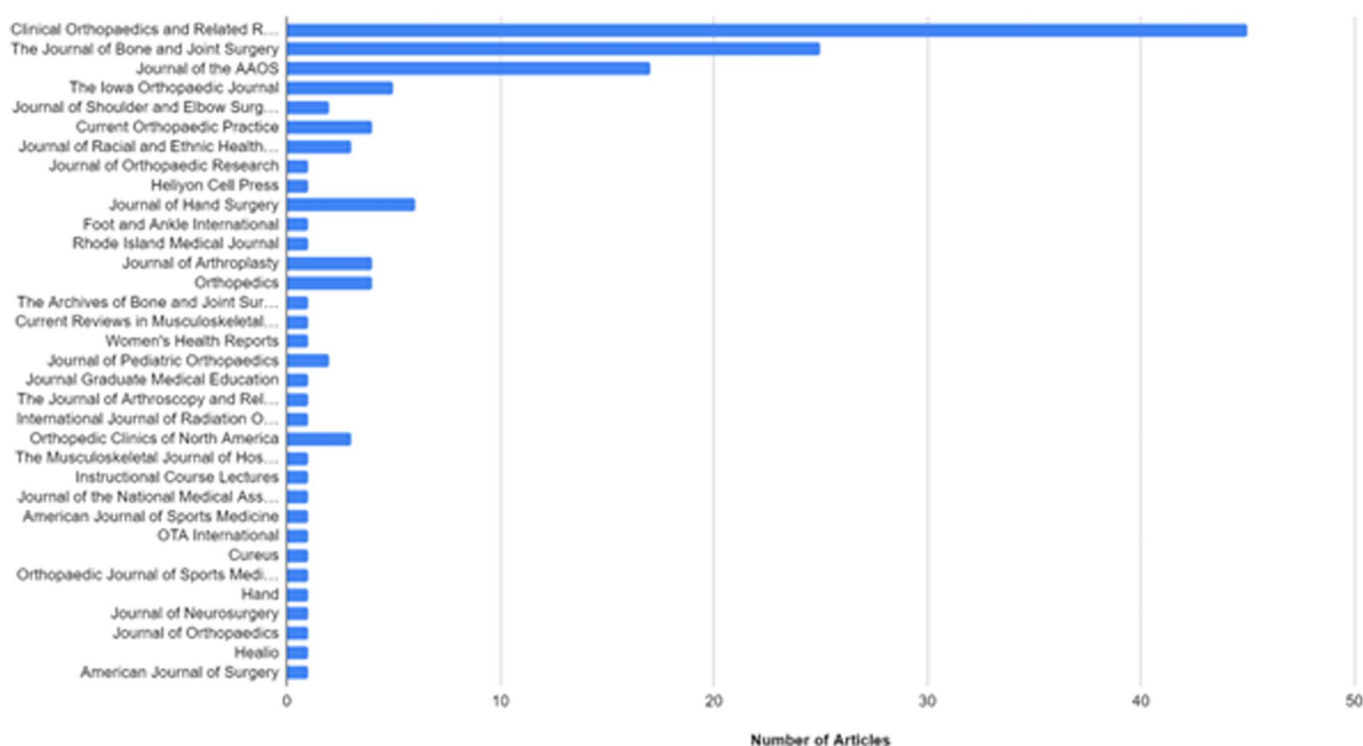


Fig. 1  
Number of DEI articles published by each journal. DEI = diversity, equity, and inclusion.

### Publications by Year

The total number of DEI publications in orthopaedic surgery has significantly grown over the past 25 years. Production of orthopaedic DEI publications peaked in 2021 with 34 articles (24%), followed by 30 (21%) in 2022, 25 (17%) in 2020, and 17 (12%) in 2019 (Fig. 2). When compared with the production of all 36 analyzed journals in the past 10 years, the growth rate in DEI-focused orthopaedic articles was much higher (Fig. 3). We defined rate as the total number of publications in each journal by year divided by the total number of DEI articles published in each journal by year.

### Publications by Authorship and Institutions

A total of 52.4% of authors were women ( $n = 75$ ) and 44.1% ( $n = 63$ ) were men (Fig. 4). Fifty-three institutions contributed to 143 DEI articles with Washington University in St. Louis producing the most DEI articles ( $n = 10$ ), followed by Cleveland Clinic, Rutgers New Jersey Medical Center, and Shriners for Children Medical Center ( $n = 4$ ). Seven institutions produced 3 DEI articles each, whereas the remaining 40 institutions produced 1 to 2 articles. Information could not be confirmed for 5 articles (Fig. 5).

### Publication Topics

A total of 42.7% of the articles focused specifically on sex ( $n = 61$ ), whereas 39.9% evaluated race/ethnicity and sex ( $n = 57$ ). Twelve percent of DEI articles consisted of race/ethnicity

( $n = 17$ ) as its focus, whereas 2.8% solely focused on inclusion (Fig. 6).

### Citation Index

When examining the publications from 1999 to 2015 ( $n = 22$ , 19.8%) compared with 2016 to current ( $n = 89$ , 80.2%), the 2016 to current had a higher mean citation index (2016-current: 6.5 vs. 1999-2015: 2.7;  $p = 0.044$ ). The authors of the 2016 to current publications were more likely to be women (odds ratio [OR]: 4.0, 95% CI: [1.5-10.9];  $p = 0.007$ ). Articles from 2016 to current have a greater focus only on sex than before 2016 (OR: 4.2, 95% CI: [1.3-13.4];  $p = 0.015$ ) but are less often focused on race/ethnicity compared with 1999 to 2015 (OR: 0.2, 95% CI: [0.1-0.6];  $p = 0.004$ ) (Fig. 7).

### Discussion

This scoping review focuses on DEI research in the field of orthopaedic surgery over the past 25 years. In our comprehensive analysis of the 143 DEI articles that met the inclusion criteria, we found that women outnumbered men in research output despite being substantially underrepresented in the field. Gender disparities in orthopaedic surgery were the most analyzed and published topic in DEI research. In the past 25 years, the University of Washington School of Medicine in St. Louis has been the greatest institutional contributor to DEI research in the field of orthopaedic surgery. Notably, 2021 had the largest net contribution of DEI

## Number of Orthopaedic Surgery DEI Articles Written by Year

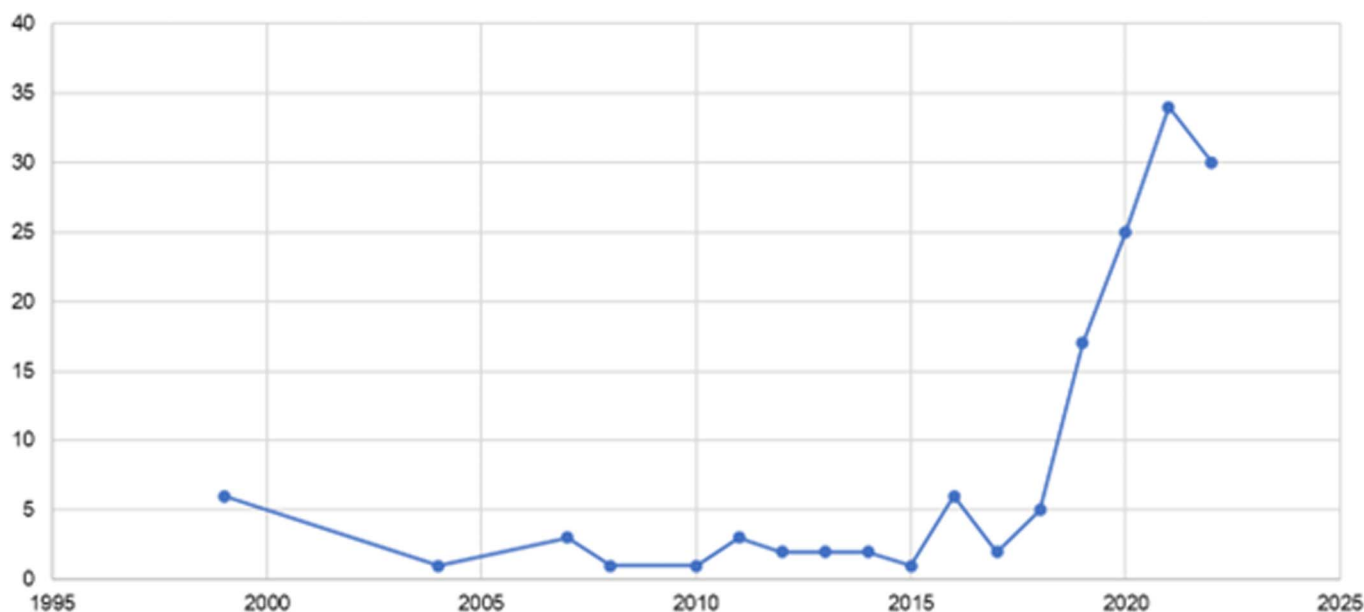


Fig. 2  
Number of orthopaedic surgery DEI articles written by year. DEI = diversity, equity, and inclusion.

articles while *CORR* published the largest number of articles, making up 31.25% (n = 45) of total articles published overall. This analysis demonstrates that DEI research in orthopaedic surgery is a relatively new domain for the specialty with increased productivity in the past 2 years, and is driven by women, with the most common focus being on gender disparities.

### Cause for Concern

Over the past 4 decades, previous research demonstrates that women publish less frequently than men across all specialties and especially in the field of orthopaedics<sup>5-9</sup>. In this study, women outnumbered men in DEI research output with 52.4% of publications led by women. Orthopaedic surgery is the least diverse specialty in medicine, and although the

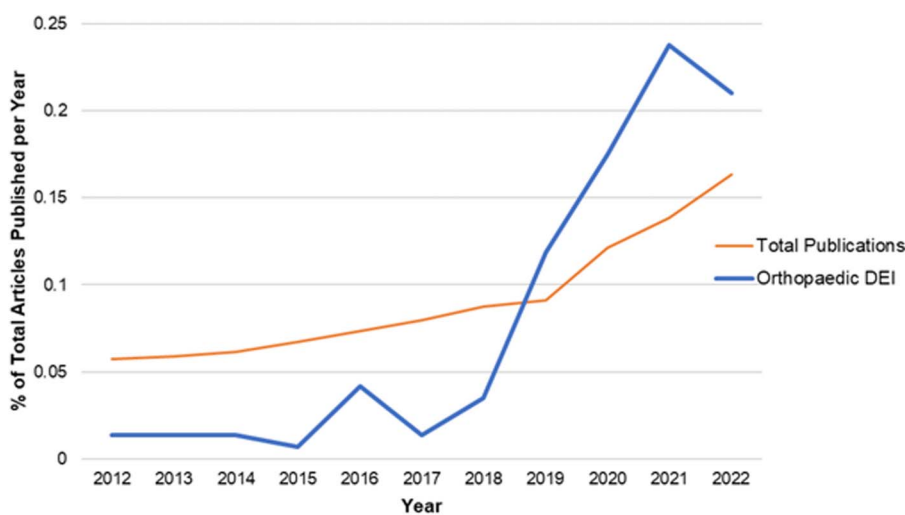


Fig. 3  
Normalized number of publications: The total number of publications in each journal by year vs. the total number of DEI articles published in each journal by year. DEI = diversity, equity, and inclusion.

**Orthopaedic Surgery DEI Research: Who is pioneering the authorship of these articles?**

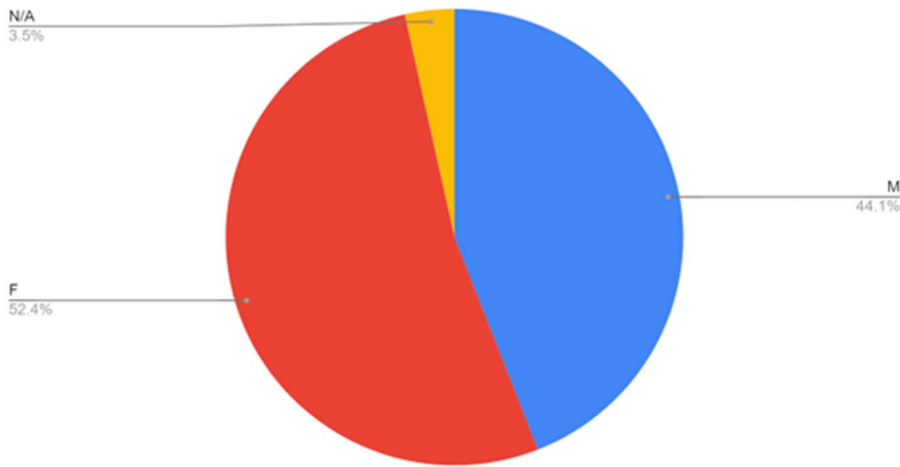


Fig. 4  
Female and male authorship in DEI research. DEI = diversity, equity, and inclusion.

number of women orthopaedic surgeons is increasing and multiple pipeline programs and diversity efforts have been created to achieve gender parity in the specialty, stark gender disparities within the specialty still exist<sup>5-22</sup>. One possible explanation is the increase in the number of women in ac-

ademic positions in orthopaedics within the past 15 years<sup>6</sup>. Furthermore, writing and research can serve as a meaningful and healthy outlet to express challenges in the work environment, and previous women authors have expressed experiences with harassment and bullying in the field<sup>23,24</sup>. The

**Number of DEI Articles Endorsed by Each Institution**

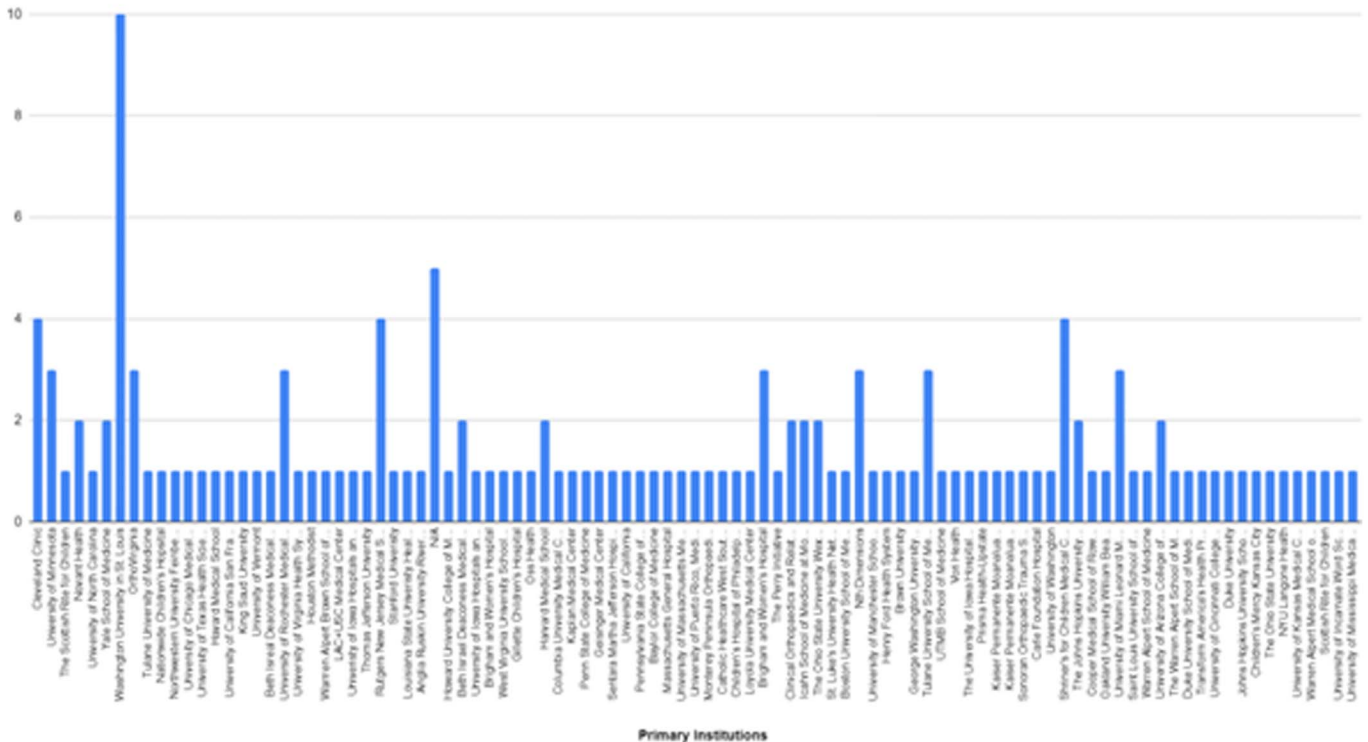


Fig. 5  
Number of DEI articles endorsed by each institution. DEI = diversity, equity, and inclusion.

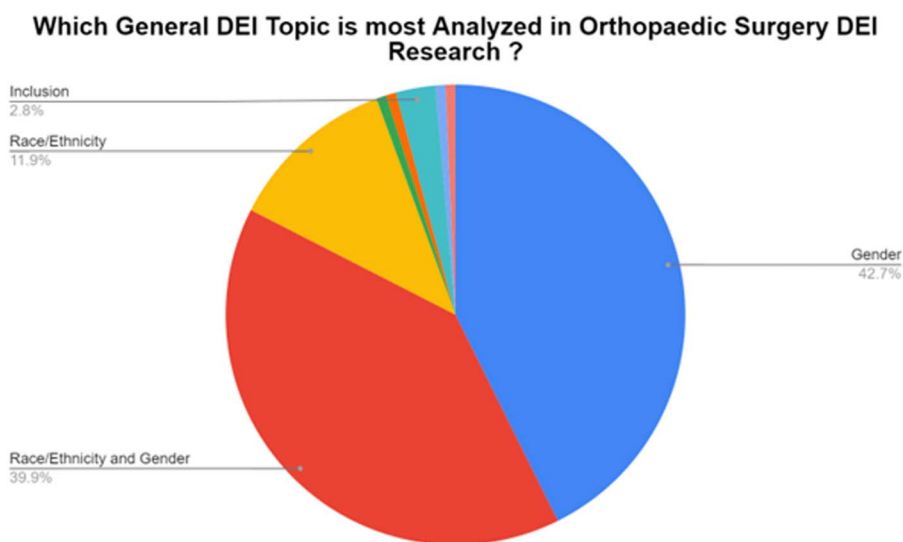


Fig. 6  
Most analyzed DEI topic in orthopaedic surgery literature. DEI = diversity, equity, and inclusion.

process of organizing tangible data illustrating the realities of training as a woman in orthopaedic surgery in the United States can garner more support and resources for gender parity advocacy within the field. This can explain the modest increase in female representation within orthopaedic resi-

dency that mirrors the chronological trend of research conducted on the same topic<sup>31</sup>.

An additional reason for the discrepancy in research is that underrepresented minority (URM) researchers, who receive less money than White researchers per funded grant, may

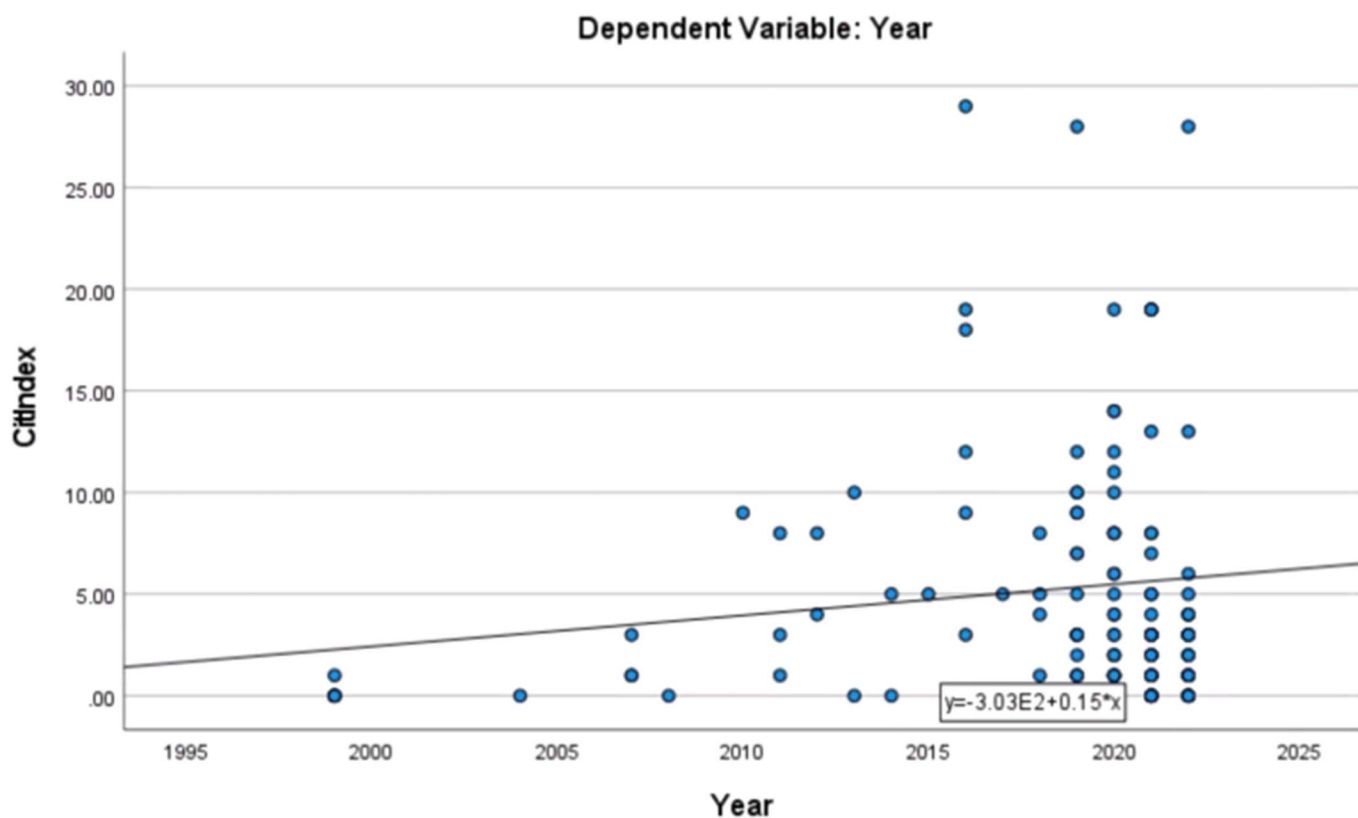


Fig. 7  
Examination of the publications from 1999 to 2015 compared with 2016 to current.



thereby be less incentivized to perform DEI research<sup>25</sup>. Our data illustrate a decreased focus on race and ethnicity disparity research in orthopaedics since 2015. This may in turn disempower these groups to tell their stories, further contributing to the underrepresentation of these groups and their challenges in orthopaedic DEI literature. Without visibility of the experiences pertaining to racial and ethnic challenges in orthopaedics, there may be less concerted efforts to combat these issues. The result of this is evident because there has been negligible improvement of racial and ethnic disparities in orthopaedics overall<sup>4,26,27</sup>.

### *Causes for Optimism*

Bright spots also exist in orthopaedic DEI research, with programs such as Washington University in St. Louis contributing heavily to DEI research in orthopaedics over the past 25 years. Of 10 articles to come out of that institution, 9 articles have been published since 2019. Five of the articles are from the same first author and senior author, *Gerull* and *Capriano*, and all of them were featured in high-impact journals. Indeed, this illustrates the positive association between authorship and institutional affiliation. The work by *Gerull* et al. demonstrates that if an author is passionate about strategic efforts to increase diversity in orthopaedic surgery and they are empowered and supported by their institution or mentor, then research output and productivity can be substantially increased. Mentorship in orthopaedics exists and has made a substantial impact on the prevalence of sex and underrepresented minorities in the field<sup>27,28</sup>. A solution to develop these relationships could include the development of an intersectional conglomerate of DEI researchers in the field to host monthly webinars and journal clubs for medical students interested in orthopaedics and DEI research. These sessions can include pairing a medical student with a mentor, information sessions on how to conduct research, write manuscripts and abstracts, and present posters; discussions about the current DEI literature in orthopaedics; and brainstorm sessions about new ideas and projects. The development of mentorship in DEI research and dedicated grants and financial support to help fund these projects and URM researchers could help add to the breadth and intersectionality of the literature and solutions targeted toward solving the DEI disparities in our specialty.

In addition to individual efforts, DEI research in orthopaedics has generally increased since 2016. The year 2021 had the largest DEI research output in orthopaedic surgery by far, which can likely be attributed to the effect that 2020 had on the world in the realm of racial injustice, social justice, and physician activism. However, there was a slight drop in publication of DEI work in 2022. One explanation could be that the popularity of illuminating racial injustice in our health-care system is slowly coming to a stop<sup>29</sup>. Another explanation could be the COVID-19 rebound effect<sup>30</sup>. During the height of the pandemic, most elective surgical procedures were rescheduled until further notice, possibly giving a large percentage of orthopaedic surgeons more time to reflect on their experiences, brainstorm strategies to combat the disparities

that hinder orthopaedics, and ultimately publish more articles in 2021<sup>29</sup>. This could imply that in the midst of national social injustice, minoritized professionals and allies in the field felt more empowered to speak out and share ideas about DEI in orthopaedics. In addition, we can consider that a solution to overcoming the barriers to DEI in orthopaedics requires the empowerment of minoritized groups and allies, a time for deep reflection and introspection to strategize solutions, and intentionally cultivating a space where these groups are encouraged to share their ideas and input and are mentored by someone who can relate to their experiences.

Moving forward, it is unsurprising that we see that most DEI studies are clustered in the same orthopaedic publications. This may be explained by the fact that authors are more likely to submit their manuscripts to journals that have a long track record of publishing articles of a specific topic. Associations with leaders prominent within the field and from URM backgrounds is one way to facilitate this, much like a column with *CORR* called "Forward Movement," led by *Owusu-Akyaw* et al. Another strategy taken by both *JBJS* and *JAAOS* is in increasing the visibility of DEI disparities in orthopaedics within the past 5 years through strategic planning, grant programs, research, soliciting manuscripts and special issues, and journal clubs and podcasts. These efforts indicate that DEI visibility in orthopaedic surgery can be improved and cultivated through recognition of the problem, thoughtful strategic planning, and consistent action. Therefore, to increase DEI in orthopaedics, leading journals in orthopaedic surgery should continue to consistently seek to improve the academic visibility of DEI research and reverberate the voices of systemically minoritized groups within the specialty<sup>15</sup>. Avenues to close this gap include the collaboration of leading journals in orthopaedics, academic centers, and organizations to enhance research quality and productivity regarding race/ethnicity and inclusion, highlighting the importance of developing strategic plans to create inclusive and safe academic environments for minoritized groups, ultimately with the goal of increasing retention of underrepresented physicians in the specialty, much like the progress we have seen in the context of gender parity<sup>31</sup>.

### *Limitations*

Our study had several limitations, which include low power due to the limited number of DEI orthopaedic publications in the past 25 years. It is possible that certain trends seen in other authorship studies could not be illustrated or evaluated because of the low number of articles we analyzed. We were unable to identify the sex of the primary author for 5 articles, which may have led to an inaccurate estimation of authorship. We also understand that an author's institutional or academic profile may not be congruent with their chosen gender identity and want to recognize this as a marked limitation of our study. However, we do anticipate performing prospective investigation into this topic and will be more comprehensive to solicit these data in the future. Other limitations include the exclusion of each author's sex, which cannot always be determined by the name of the author. Our study was also limited by language, in

which we were only able to evaluate the work of English speakers and writers, which ultimately limited the viewpoints of populations who speak other languages in our study. Finally, our data were limited by sex, leaving us unable to explore race/ethnicity, sex diversity, or any other forms of intersectionality. The limited exploration of intersectionality in our research excludes populations who hold more than one underrepresented identity (e.g., a black woman or a gay Asian male) and their significance and experiences in our study. Intersectionality in this study matters because to solve the disparities within orthopaedics, we must capture and understand the experiences of people who navigate the world through multiple lenses from all angles.

### Conclusion

The objective of this study was to illustrate the trends of DEI research in the field of orthopaedic surgery. Gender parity research has been heavily emphasized in the past 10 to 15 years and has paid dividends by way of female representation in orthopaedic residency. Although the number of articles written since 1999 in this domain has more than quadrupled in output, there is substantial room to grow in the areas of race/ethnicity and inclusion within the specialty. Efforts from all involved, including specialty and advocacy organizations, institutions,

and journals, are heavily appreciated to navigate the best strategies to fill this void and encourage equal representation within orthopaedic surgery. ■

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