Original Article

Persistent Gender Disparity in Authorship of Arthroscopic Surgery Research

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Purpose: To examine how the gender of the first and last authors of annual meeting abstracts and journal articles from a related source have changed between 2012 and 2022. **Methods:** All abstracts and original research articles published from 2012 to 2022 were extracted from the websites of The Arthroscopy Association of North America and *Arthroscopy: The Journal of Arthroscopic and Related Surgery*, respectively. The full names of first and last authors were analyzed with the validated Genderize algorithm. Analyses were performed to evaluate authorship of abstracts and articles. **Results:** Of 850 abstracts, 845 (99.4%) had an identifiable first-author gender and 843 (99.2%) had an identifiable last-author gender. The proportion of female first authors increased from 9.2% in 2012 to 15.2% in 2022, whereas the proportion of female last authors decreased from 13.5% in 2012 to 12.3% in 2022. Of 4,811 articles, 4,744 (98.6%) had an identifiable first author gender and 4,767 (99.1%) had an identifiable last author gender. The proportion of female first authors increased from 10.4% in 2012 to 16.8% in 2022, whereas the proportion of female last authors decreased from 19.0% in 2012 to 9.1% in 2022. For both abstracts and articles, the gender of the last author was not significantly associated with the presence of a female first author. **Conclusions:** Between 2021 and 2022, there was a significant increase in the proportion of female first authors of both abstracts and articles examined in this study. However, a similar increase was not seen among last authors. **Clinical Relevance:** It is important to examine gender representation among authors who publish arthroscopic research to understand how a greater balance may be achieved.

Although there is an overall goal toward the achievement of gender parity in medicine, women remain under-represented in many surgical fields.[1] This disparity is especially apparent in orthopaedic surgery: in 2020, only 16% of orthopaedic surgery residents and 6% of practicing orthopaedic surgeons were female.[2] Gender disparities are further heightened as academic rank increases within orthopaedic surgery.[2] A 2011 study found that only 19% of tenured professors and 17% of full professors were women, a stark decrease from the 41% of female assistant professors.[3] Indeed, orthopaedic surgery is the least gender-diverse specialty as recognized by the Accreditation Council for Graduate Medical Education, falling behind similarly competitive specialties including general surgery, neurologic surgery, vascular surgery, and urology.[4]

There is a growing body of literature describing gender disparities within orthopaedic subspecialties.[5-8] Gender disparities among orthopaedic sports medicine physicians begin in fellowship[9] and remain persistent when analyzing team physicians[10] and leadership in sports medicine societies.[11] Within the realm of academic sports medicine, the literature has demonstrated disparities in the authorship of publications from 1972 to 2018.[12]

Given that nearly one half of current medical school matriculants identify as female,[13] it is especially concerning that disparities in orthopaedics still persist. It is likely that a variety of factors contribute to the persistence of these disparities, including a relative paucity of exposure to the wide variety of surgical subspecialties in medical school, persistent misperceptions about orthopaedic surgery, and unconscious gender biases.[14] As

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such, many believe that early exposure to and retention of medical students interested in orthopaedic surgery may help to narrow these disparities.[15]

The purpose of this study is to examine how the gender of the first and last authors of annual meeting abstracts and journal articles from a related source have changed between 2012 and 2022. We hypothesized there would be improvements in gender parity among first authorship, reflective of increased female medical student and early trainee interest in orthopaedic surgery and orthopaedic sports medicine.

Methods

This was an observational study of all abstracts accepted to the annual meeting of the Arthroscopy Association of North America (AANA) and of all research articles (20 article types including original articles, systematic reviews, infographics, and Level V Evidence) published in *Arthroscopy: The Journal of Arthroscopic and Related Research* from 2012 to 2022. Because these 2 sources are linked, all data were extracted from the *Arthroscopy* website. There were no abstracts or articles excluded. First- and last-author gender were assigned using the validated Genderize algorithm (https://genderize.io/). If the Genderize algorithm produced an indeterminable gender of the first and/or last author, the author was searched on the internet (U.B.). If the gender remained indeterminable, that author was included as having an unknown gender in our analyses. For abstracts and articles with only one author, the author was included as the first author and no last author assigned.

The data were analyzed using IBM SPSS Statistics, Version 28.0 (IBM Corp LLC). Linear regression was used to analyze the relationship between the year and author gender, with the first or last author gender as the dependent variable and the year as the independent variable. The P value, regression coefficient (β), and 95% confidence interval were reported when the data were statistically significant ($P < .05$). Linear regression was used to describe first- and last-author gender for abstracts, articles, and articles by category.

Results

The initial extraction resulted in 847 abstracts and 4,810 articles. Of included abstracts, 99.4% had an identifiable first-author gender and 99.2% had an identifiable last-author gender. After an Internet search, 99.9% had an identifiable first author gender and 100.0% had an identifiable last author gender. Of abstracts with identifiable author genders, 11.8% had a female first author and 13.4% had a female last author. The proportion of female first authors increased from 9.2% in 2012 to 15.2% in 2022, demonstrating a statistically significant increase ($P = .017$; $\beta = -0.73$; 95% confidence interval 0.23-1.8). There was no significant change in the proportion of female last authors, with 13.2% in 2012 and 12.1% in 2022 ($P = .75$) (Fig 1). In total, 84.0% of abstracts with male last authors had female first authors and 14.0% of abstracts with female last authors had female first authors.

Of 4,810 articles, 98.6% had an identifiable first author gender and 98.9% had an identifiable last author gender using the Genderize algorithm. After an internet search, 99.3% had an identifiable first author gender and 99.3% had an identifiable last author gender. Of articles with identifiable author genders, 10.9% had a female first author and 20.3% had a female last author. The proportion of female first authors rose from 10.3% in 2012 to 16.7% in 2022, though there were no statistically significant changes over time ($P = .89$). The proportion of female last authors decreased from 19.1% in 2012 to 9.0% in 2022, though these changes were not statistically significant ($P = .99$). The proportion of female last authors peaked in 2019 at 40.1% (Fig 2). In total, 11.1% of "original articles" had female first authors whereas 10.3% of all other article types had female first authors. In total, 18.8% of "original articles" had female last authors while 23.1% of all other article types had female last authors. In total, 72.5% of articles with male last authors had female first authors and 2.02% of articles with female last authors had female first authors.

Discussion

Our results indicate that persistent gender disparities exist in the field of arthroscopic surgery. Of abstracts published from 2012 to 2022, only 11.8% had a female first author and 13.4% had a female last author. Of articles published in the same period, 10.9% had a female first author and 20.3% had a female last author.

Although gender trends for orthopaedic sports medicine articles have been described previously, this study adds to such bibliometric analyses by describing data for both abstracts and articles in orthopaedic sports medicine. Indeed, it should be noted that out of first and last authors for both abstracts and articles, significant increases in the percentage of female authors were only noted for first authors of abstracts (from 9.2% to 15.2%, $P = .017$). Because first authorship for an abstract often serves as an entry point into academic medicine, it is encouraging that this role has been fulfilled by an increasing number of female authors. However, it is simultaneously discouraging that similar results were not seen for last authors of abstracts, nor for first or last authors of articles. Because research productivity plays a critical role in academic advancement, the reasons for these statistically nonsignificant changes must be explored.[3,16]

Contrasting with a similar study of gender disparities in pediatric orthopaedic surgery articles, we found that researchers were not significantly more likely to

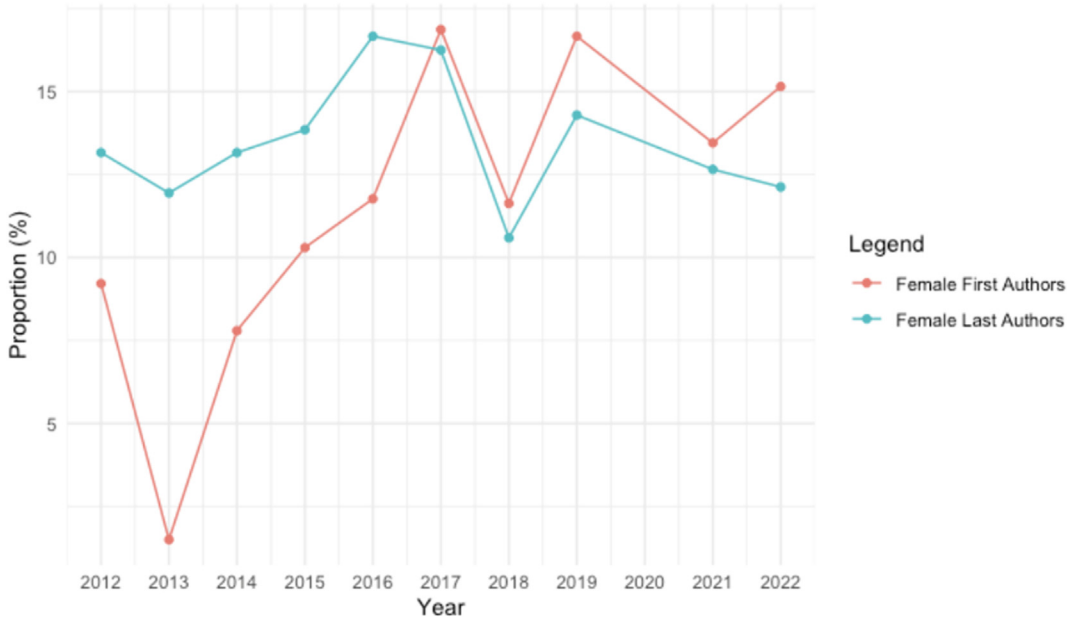

Fig 1. Proportion of abstracts with female authors from 2012 to 2022.

collaborate with individuals of the same gender.[5] This was surprising, given findings of women reporting significant benefits to same gender mentorship,[17] particularly in regard to personal development, career selection and navigation, and research productivity.[15] Although the etiology of our findings must be further investigated, it is notable that women in academic medicine have greater difficulty finding a mentor than do their male counterparts.[18] Given the relative lack of female representation in orthopaedic surgery as a whole and in orthopaedic sports medicine more specifically,[11] it is reasonable to hypothesize that our findings may be due to a paucity of female mentors in arthroscopic surgery and research. Nevertheless, our findings suggest that both male and female senior authors may play a significant role in mentoring early career females interested in arthroscopic surgery to help lessen the gender gap.

Although it is difficult to determine why female authorship of abstracts and articles have not significantly increased, aside from the significant increase in female first authorship of abstracts, a commonly cited

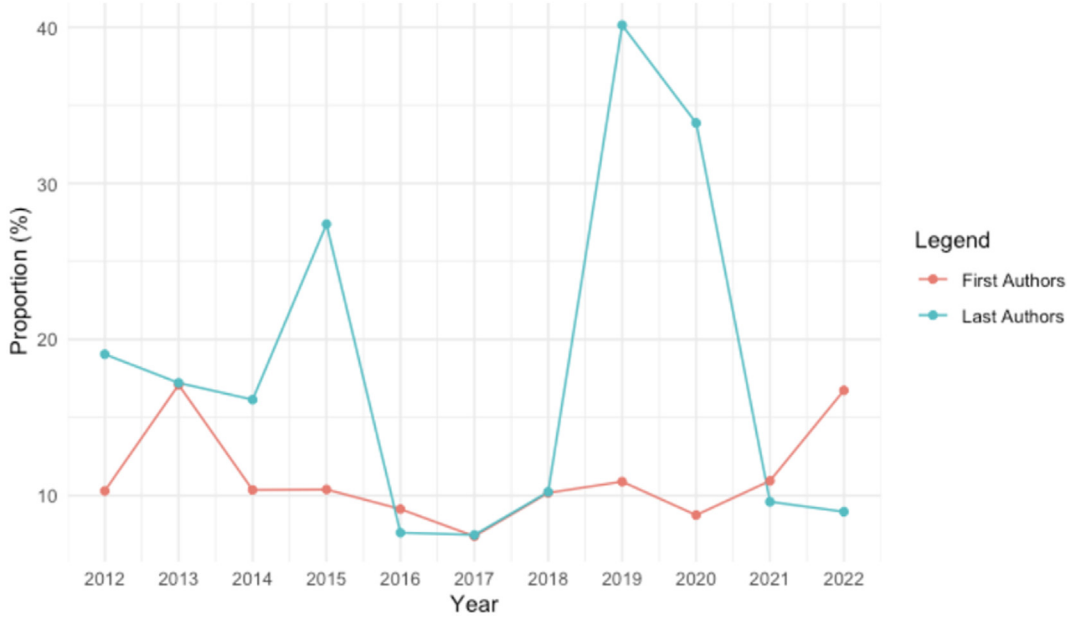

Fig 2. Proportion of publications with female authors from 2012 to 2022.

reason may be the assumption of nonwork-related responsibilities, which may be particularly important in contextualizing findings regarding the proportion of female last authors.[12] Hariri et al.[19] surveyed senior orthopaedic residents and surgeons and found that significantly more women planned on reducing their future work hours or undertaking a part-time status than men. We found the largest decrease in female last authors of articles from 2019 (40.2%) to 2022 (9.07%), the years during which the COVID-19 pandemic occurred. It is plausible that during the pandemic, female surgeons reduced the time spent on academic responsibilities in order to dedicate more time to nonwork responsibilities. As such, our findings only highlight the weight of previously described competing responsibilities that female clinician-scientists may face.

Efforts to correct gender disparities should be implemented at interpersonal and institutional levels. Zhuge et al.[3] propose increased flexibility for tenure-track positions, offering protected research time or increased allotment for familial obligations. Lewis et al.[14] suggest the early recruitment of female medical students to orthopaedic surgery, offering strong mentorship, preferably from female attendings who may serve as role models. Such strategies have been successfully implemented by the Perry Initiative's Medical Student Outreach Program, aimed at female mentorship: program alumnae had a match rate double that of the percentage of all females in orthopaedic residency programs.[20]

Limitations

This study is not without limitations. First, we only focused on abstracts from AANA's annual meetings and research articles from *Arthroscopy: The Journal of Arthroscopic and Related Research*. Although we initially considered expanding the journals we included, we instead prioritized focusing on both abstracts and articles from these 2 reputable and prominent sources, which are linked (as *Arthroscopy*'s society partner is AANA), thereby suggesting that a similar body of researchers and surgeons submit their work to both. Additionally, we only analyzed first and last authors, excluding middle authors from our analyses. Further, there may be errors with the Genderize algorithm's identification of authors' genders. Finally, we were unable to assess the academic degrees or specialties of investigated authors. This prevented us from describing female authorship throughout different career stages.

Conclusions

Between 2021 and 2022, there was a significant increase in the proportion of female first authors of both abstracts and articles examined in this study. However, a similar increase was not seen among last authors.

Disclosures

All authors (U.B., A.R.L., N.H.K., C.V., J.P., K.S.N., A.C.C.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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