

Exploring the gender gap in neurosurgery: A cross-sectional analysis of preresidency publications among neurosurgery residents

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Abstract

Background and Aims: While the number of female physicians has increased since the 1970s, there continues to be a lack of female surgeons compared to their male counterparts, with the gender gap more prominent in surgical subspecialties such as neurosurgery. While surgical subspecialties have accelerated initiatives to close the gap, potential disparities in research opportunities may position women at a disadvantage, particularly in neurosurgery, where academic publications are an indicator of residency match success. In this paper, we sought to investigate whether gender disparities exist in preresidency neurosurgery publications among current neurosurgery residents.

Methods: The present study selected residency programs from the top 25 neurology and neurosurgery hospitals in US News & World Report's 2022 Ranking. A database of neurosurgery residents and their publications was created using PubMed, neurosurgery residency program websites, and supplementary search. Articles published between the time of birth and December 31st of the year of graduation (medical degree) were used to determine publications before residency.

Results: Our research indicates that 25.7% ($n = 135/526$) of US neurosurgery residents at top 25 hospitals are women and 74.3% ($n = 391/526$) are men. Men ($n = 391$) had a median of 7 (interquartile range [IQR], 3–14.5; range, 0–129) publications before residency, and women ($n = 135$) had a median of 7 (IQR, 4–11.0; range, 0–74) publications before residency. There were no significant differences in the median number of publications between genders ($p = 0.65$).

Conclusion: In conclusion, our research indicates there is no gender disparity in preresidency publications among neurosurgery residents. To improve women's representation in the field, further study is needed to better understand gender inequality among neurosurgeons, particularly in the earlier stages of medical training.

KEYWORDS

academic medicine, gender disparities, medical education, neurosurgery, publication output, residency match

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1 | INTRODUCTION

Over the course of the last 50 years, women's representation in medicine has increased significantly. In 1970, only 7% of practicing physicians were women.¹ Fast forward to the present day, and now nearly 40% of physicians are women.^{1,2} This trend is expected to continue as well, with the Association of American Medical Colleges (AAMC) reporting that 54% of medical students in the 2022–2023 academic year were women.³ Despite overall progress, a disparity remains in the representation of women in certain medical fields, particularly competitive surgical fields such as neurosurgery.

While there have been initiatives and calls for reform to increase women's representation in neurosurgery,⁴ many questions remain regarding the potential causes of this gender gap. Some have suggested that a lack of mentorship, clinical exposure, and limited research opportunities may contribute to the underrepresentation of women in neurosurgery, both in terms of recruitment and career advancement.⁵ Although the lower representation of women in neurosurgery compared to men (30% vs. 70% in 2022) can be attributed to the disparity in the number of female and male applicants,⁶ it does not account for the higher likelihood of successful matches among male applicants compared to female applicants. From 2010 to 2020, male applicants were more likely to match successfully into neurosurgery than females (73% vs. 62%), even after adjusting for favorable factors such as United States Medical Licensing Examination step 1 score, medical school ranking, and Alpha Omega Alpha status.⁷ Moreover, despite the ongoing rise in the number of female applicants, the disparity in applicant numbers may stem from factors that deter women from applying initially, such as academic publications, known to contribute to a competitive application for neurosurgery residency.

As highlighted by Kabangu and colleagues, it will take at least another 40 years for gender parity in applicants to be achieved if current application trends continue.⁶ To narrow the gender gap in a shorter amount of time involves identifying contributing factors before individuals apply to residency programs. In this paper, we investigate disparities that may arise early in physician training (i.e., during medical school) and contribute as a potential barrier of entry into the field. Specifically, it is known that research productivity, or a lack thereof, is associated with match performance among neurosurgery residency applicants.⁸ Gender disparities in research opportunities—and resultant publications—may discourage female medical students from pursuing a career in neurosurgery, or at the very least, create challenges during the residency match process. Therefore, the present study aims to examine potential gender disparities in preresidency publications among current neurosurgery residents, a proxy for neurosurgery residency applicants as unmatched applicant data is nonidentifiable.

2 | METHODS

A comprehensive list of neurosurgical residents, compiled in July 2022, was created from residency programs affiliated with the top 25 neurology and neurosurgery hospitals, as ranked by the US

News & World Report 2022 ranking.⁹ The demographic characteristics—including postgraduate year (PGY), gender, medical school, medical school ranking, and year of medical degree (MD) attainment—were determined using residency program websites and supplementary search. The ranking of medical schools was determined by referencing US News & World Report's 2022 ranking for “Best Medical Schools: Research.”¹⁰ Programs that did not appear in the top 95 rankings were considered unranked.

Research output was determined using peer-reviewed publications listed in PubMed (PubMed Identifier [PMID]; pubmed.gov). To adjust for the number of PMID publications before residency, only articles published between the physician's time of birth and December 31st of the year in which they graduated (MD) were included. PMID publications were classified into categories based on the type of journal in which they were published (i.e., neurosurgical or neuroscience focus, or not). Additionally, the authorship position was recorded.

Mann-Whitney *U*-tests were used to compare differences in research output between the two genders. $p < 0.05$ was set as the threshold for significance a priori, and all analyses were two-sided. Microsoft Excel, version 16.67 was used for data collection. Descriptive statistical analysis was conducted using R statistical software (version 2022.02.1; Build 461).

3 | RESULTS

Of 526 neurosurgical residents examined from residency programs affiliated with the top 25 neurology and neurosurgery hospitals, 25.7% ($n = 135/526$) were women and 74.3% ($n = 391/526$) were men. The median PGY was 4 for both genders, and the median year of attaining an MD was 2018 for men and 2019 for women. Furthermore, the median ranking of the medical school attended by neurosurgical residents was 20.

Before entering residency, the median number of publications among men ($n = 391$) and women ($n = 135$) was 7 (interquartile range [IQR], 3–14.5; range, 0–129; IQR, 4–11.0; range, 0–74, respectively). There were no significant differences in the median number of publications before residency between the genders ($p = 0.65$).

Additionally, the categorical analysis revealed that men had a median of 4 neurosurgery/neuroscience-related publications and 2 nonneuro-related publications before residency. Similarly, women had a median of 3 neurosurgery/neuroscience-related publications and 2 nonneuro-related publications before residency. There was no significant difference in the number of neurosurgery/neuroscience-related publications between the genders ($p = 0.27$). Lastly, both men and women had a median of 2 first-author publications and 0 last-author publications.

4 | DISCUSSION

In the current clinical and academic landscape, the representation of women in neurosurgery remains low compared to other medical specialties.¹¹ This study sought to better understand research

productivity in medical school, specifically gender differences in the number of publications, an indicator of match success and entry into a neurosurgical residency.⁸ However, the findings of this research show no significant difference in the median number of preresidency publications, authorship position, or neuro-related publications between men and women. Here, we explore two implications of these results.

First, it is noteworthy that preresidency research productivity between the genders exhibits relatively equal distribution. This stands in contrast to gender disparities observed in research productivity during residency, academic advancement at the attending level, and representation in leadership positions at the organizational level.^{12–14} While continued efforts aimed at establishing equality remain a pressing issue, it is encouraging that differences may not present themselves during the earliest stages of training regarding research productivity. Nonetheless, this view must be tempered by considering the next point.

Second, while there were no observed differences in PMID publications between genders, disparities may still exist in non-indexed research items such as book chapters, posters, abstracts, and oral presentations, which are not subject to the same rigorous peer-review as the former. Nonindexed items are eligible for listing in the publication section of the Electronic Residency Application Service (ERAS), and therefore, play a contributing factor for residency selection. According to the 2022 residency match data for United States MD seniors, the average number of research items for applicants matching into neurosurgery was 25.5, whereas for applicants who did not match, it was 11.7.¹⁵ Given ERAS research items are self-reported and encompasses both indexed and nonindexed research, verification may present challenges, but the topic remains a possible area of investigation to address an open question.

5 | LIMITATIONS

The present study has four limitations. First, neurosurgical residents were used as proxies for individuals who applied to neurosurgery residency. This methodology, while not necessarily reflective of the average applicant to neurosurgery, was utilized due to the unavailability of data from unmatched applicants.¹² Second, this investigation was limited to neurosurgical residents from programs associated with the top 25 neurology and neurosurgical hospitals. Had an analysis included every neurosurgical residency program nationwide, the findings may have differed. Third, only PubMed was used to investigate the research productivity of neurosurgical residents. Not all medical journals are indexed in PubMed, thus potentially resulting in the exclusion of some peer-reviewed manuscripts. Fourth, the current study reveals a median of 7 preresidency publications per resident, similar to Sheppard et al., who recorded a comparable value between the years 2011 and 2018 (average 6.5 preresidency publications, CI [5.1, 7.9]).¹⁶ Despite similar preresidency publications overall, the researchers observed a significant

difference in preresidency publications between genders (Men vs. Women; 4.6 vs. 3.7; $p = 0.032$).¹⁶ However, this discrepancy was only observed half the time of the 8-year study period, and its practical implications are yet to be determined.¹⁷

6 | CONCLUSION

In this paper, we aimed to examine potential gender disparities in research productivity in preresidency publications among neurosurgery residents. Our findings show that out of 526 neurosurgery residents affiliated with the top 25 neurology and neurosurgical hospitals in the United States, 25.7% ($n = 135$) are women and 74.3% ($n = 391$) are men. Both male and female residents had a median of seven publications before residency, displaying no significant difference ($p = 0.65$). This study suggests there is no gender disparity in preresidency PMID publications among neurosurgery residents, however it remains unknown whether gender disparities exist among medical students interested in pursuing neurosurgery or those that fail to match into neurosurgery residency successfully. Further research is warranted to explore different cohorts and consider nonindexed research items to ensure a comprehensive representation of ERAS submissions.

AUTHOR CONTRIBUTIONS

Kerrington Powell conceptualized the study design. Kerrington Powell, Annie Huang, Taimur Hassan, Akash Kakkilaya, and Apoorva Kakkilaya reviewed the literature. Annie Huang, Taimur Hassan, Akash Kakkilaya, Apoorva Kakkilaya, and Kristen Downey curated data. Taimur Hassan and Akash Kakkilaya performed statistical analysis. Kerrington Powell reviewed and confirmed abstracted data. Kerrington Powell wrote the first draft of the manuscript. All authors have read and approved the final version of the manuscript. Kerrington Powell had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data sets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The manuscript and accompanying data were collected in accordance with Wiley's Best Practice Guidelines on Publishing ethics. Institutional Review Board approval was not sought as all data sources were publicly accessible.

TRANSPARENCY STATEMENT

The lead author Kerrington Powell affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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