Assessment of female authorship in *Journal of NeuroInterventional Surgery* (JNIS) publications in 2016–2020

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Original research

**ABSTRACT**

**Background** Since female neurointerventionalists make up a minority of the workforce, the contributions this group has made to academic scholarship should be highlighted.

**Objective** The main objective of this project was to identify all of the recent papers published in the *Journal of NeuroInterventional Surgery* (JNIS) by female first authors or last authors over 5 years.

**Methods** The online issues of JNIS from January 2016 through December 2020 were reviewed. Data were collected on the number and types of articles published monthly. For each article, the gender of the first author and the senior author was evaluated. Bivariate analyses were performed to compare female authorship trends between 2016 and 2020.

**Results** In 2016, 38 (14.8%) of the 257 articles published had female involvement compared with 60 (22.8%) of 263 articles in 2020 (p=0.019). In 2016, 9.7% of all articles had a female first author only, 3.9% had a female last author only, and 1.2% had both a female first and last author. In 2020, the percentages increased to 14.5%, 6.5%, and 1.9% respectively. Over 80% of the articles published in 2016 and 2020 by female authors were original research articles. One editorial commentary and two special topic articles were published by female authors in 2020 compared with none in 2016.

**Conclusion** More papers were published by female authors in JNIS in 2020 relative to 2016. Most of these papers had a female first author, and were original research articles.

**INTRODUCTION**

Despite there being more students who identify as women matriculating in medical school, there are a number of medical and surgical specialties in which a large gender gap persists between women and men physicians. Neurointerventional surgery is a small, hybrid subspecialty that mainly specializes in the use of minimally invasive technologies to treat disorders of the brain and spine. The number of women trainees who practice neurointerventional surgery or pursue such training is low.

In specialties in which women are historically underrepresented, finding a female faculty member in a leadership position is a rarity. However, there is a link between research productivity and academic advancement. In a study conducted by Battaglia et al in 2020, only 19% of leadership positions within academic surgery were occupied by women.

The topic of female scholarship has been assessed in the literature to gauge the extent of female contribution to their respective fields. These papers describe female authorship trends in high-impact journals in the field of neurosurgery, neurology and radiology, and have generally demonstrated increasing female representation in recent years. No such article exists for neurointerventional surgery specifically. Therefore, our main objective is to describe the trends in female authorship by highlighting papers published by female first authors and last authors in the most widely read journal in the specialty, the *Journal of NeuroInterventional Surgery* (JNIS), over the past 5 years.

**METHODS**

This was a retrospective study that was conducted using the JNIS archives section on the journal’s website. Every monthly issue of JNIS that was originally published from January 2016 through December 2020 was reviewed. This amounted to 60 monthly issues. Data were collected on the number and type as well as authorship of articles published within each issue. For each article, the gender of the first author and the last author was assessed based on the name. If the name offered ambiguity with respect to the author’s gender, then an online search of the individual’s public LinkedIn or ResearchGate profile was performed to determine if he/she identified as female. If the author lacked a digital footprint, gender was deduced based on different individuals with the same name as per a Google Search.

We then created the following categories: female first author with male last author, male first author with female last author, female first author with female last author, and male first author with male last author. Additionally, the types of articles published included editor’s column, editorial commentary, original research papers, case reports/cases series, reviews, and special topics. The special topics were often published as electronic pages only and included topics like standards and new devices and techniques. Since 2020, JNIS has also started to accept technical video submissions as well as literature on the COVID-19 pandemic. Articles that were included in the supplemental section of a monthly...
issue were not counted. Lastly, articles that were published in earlier years and republished electronically during the 2016 or 2017 time period were excluded as well.

All of the articles were added together to calculate the total number of articles published in 1 year alone, out of the 5 years. Then, the percentage of female involvement was calculated annually by taking the sum of articles that had either a first or last female author and dividing by the total number of articles that year. Totals were also calculated for each authorship category and each article type to visualize any possible trends. The articles that were published in 2016 were compared with articles published in 2020 using bivariate analyses. Differences in female authorship, authorship combinations and article types were evaluated. Bivariate analyses were performed using the χ² test for categorical variables. All statistical analyses were done using the Stata 16 software.

RESULTS

General trends

In 2016, a total of 257 articles were published. Of those, 14.8% (n=38) articles had either a first or last female author, and this rose to 22.8% (60 out of 263 articles) in 2020 (table 1). This difference was found to be statistically significant (p=0.019). Over the years, there was an increase in the percentage of female involvement in each of the sub-categories of female authorship; the difference, however, was not found to be statistically significant (table 1). For example, 9.7% of articles had a female first author in 2016 compared with 14.5% in 2020 (p=0.099). The percentage of articles with both female first and last authors in 2016 versus 2020 was nearly identical (1.2% vs 1.9%).

In table 2, only the articles with female involvement were compared. There were 38 articles in 2016 and 60 articles in 2020. No statistically significant differences were found in terms of the article type over the 5 year period. For example, the vast majority of articles published by female authors were original research articles (81.6% in 2016 vs 81.7% in 2020, p=0.991) followed by case reports and then reviews.

Original research articles

The majority of articles published annually by JNIS are classified as original research articles. In 2016, 16.9% (31 out of 183) of original research articles had female involvement. This rose steadily over the years. In 2017, 25.1% (44 out of 175) of original research articles had female involvement, rising to 31.4% (49 out of 156) in 2020. Most of the original research articles that contained any type of female involvement were actually written by female first authors with male last authors. The number of original research articles written by female first authors with male last authors ranged from 18 in 2016 (figure 1) to 30 in 2020 (figure 2). The number of original research articles that were authored by a male first author with female last author was far fewer and ranged from five to 14, with only five original research pieces written by a female last author in 2018. Lastly, the number of original research articles written by both a female first and last author was low (ranging from 0 in 2018 to five in 2020). Given the sparsity of women in this field, it is not surprising that from 2016 to 2020, only 16 articles were published that had both a female first and last author and, with the exception of two articles, 14 of them were original research articles.

After original research articles, case reports and case series are the second most common type of article to be published in JNIS, and the picture was similar to that of the original research articles. In 2018, the highest percentage of female involvement in case reports was reported: 23.4% (11 of 47 case reports) had female involvement, eight of which were written by female first author with male last author, two were by a male first author....

Table 1 Female involvement in the articles published in 2016 versus 2020

| Characteristics                          | 2016 publications (n=257) | 2020 publications (n=263) | P value |
|------------------------------------------|---------------------------|---------------------------|---------|
| Total female involvement                | 38 (14.8%)                | 60 (22.8%)                | 0.019   |
| Female first author/male last author    | 25 (9.7%)                 | 38 (14.5%)                | 0.099   |
| Male first author/female last author    | 10 (3.9%)                 | 17 (6.5%)                 | 0.186   |
| Female first author/female last author  | 3 (1.2%)                  | 5 (1.9%)                  | 0.497   |

Figure 1 JNIS publications in 2016 based on the gender of the first and last authors.

Table 2 Article types written by female authors in 2016 versus 2020

| Characteristics                          | 2016 publications (n=38) | 2020 publications (n=60) | P value |
|------------------------------------------|--------------------------|--------------------------|---------|
| Editor’s column                          | 0 (0%)                   | 0 (0%)                   | 1.000   |
| Editorial commentary                     | 0 (0%)                   | 1 (1.7%)                 | 0.424   |
| Original research                        | 31 (81.6%)               | 49 (81.7%)               | 0.991   |
| Case report/series                       | 4 (10.5%)                | 7 (11.7%)                | 0.862   |
| Review                                   | 3 (7.9%)                 | 1 (1.7%)                 | 0.129   |
| Special topics                           | 0 (0%)                   | 1 (1.7%)                 | 0.424   |
| Video                                    | 0 (0%)                   | 0 (0%)                   | 1.000   |
| COVID-19 pandemic                        | 0 (0%)                   | 1 (1.7%)                 | 0.424   |

Figure 2 JNIS publications in 2020 based on the gender of the first and last authors.
with female last author, and one was written by both a female first and last author. Note that 2018 was the only instance in which a case report was written by both female first and last authors over the 5 year time period.

**Reviews**
Fewer reviews were published in JNIS relative to original research articles or case reports. Female involvement ranged from 7.7% in 2020 (n=1) to 14.3% (n=3) in 2016. In 2019, of the 14 reviews published, 14.3% (n=2) had female involvement. One was written by a female first author with male last author, while the second one was written by both female first and last authors. This was the only instance in which a review had both first and last female authorship over the 5 years.

**Editorial columns and commentaries**
During our study period of 2016–2020, 10–12 editor’s columns and 4–13 editorial commentaries were published annually. Nearly all of the editorial columns and commentaries were written exclusively by male authors. For the first time in the journal’s history in 2018, one editor’s column and one editorial commentary each were written by a female first author with a male last author. Then, again in 2020, there was one editorial commentary that had female involvement; it was written by a male first author with a female last author (figure 2).

**Special topics including COVID-19 pandemic and technical videos**
Special topics include letters to the editor, standards, technical reports, in memoriam/history, imaging, commentary, and new devices and techniques, among others (figure 1). In 2017, there were 11 articles under the special topics category and they were all written exclusively by male authors. In 2020, there were 24 articles on special topics. Only one of those articles was written by a female first author with a male last author and it was specifically on the topic of general neurointervention (figure 2).

In 2020, two new categories of publications arose in the monthly issues of JNIS. The first category consisted of articles pertaining to the COVID-19 pandemic and neurointervention. There were seven articles written on this topic and only one of those articles was written by a female first author with male last author. The second category of new publications was technical videos. Ten technical videos were published in 2020 and all 10 of them were created by male first and last authors.

**DISCUSSION**
The overall trend during a 5 year period from 2016 to 2020 has shown an increase in the number of JNIS publications that were composed by female authors. However, when breaking down the analyses by type of publication, no difference in female involvement emerged over the years. The majority of publications (>80%) containing female involvement consisted primarily of original research articles followed by some case reports and very few reviews. Articles that were on special topics and technical videos fared poorly in terms of female involvement, as was the case for editorial columns and commentaries. Lastly, our results showed that the majority of publications (>60%) that comprised female authorship had a female first author with a male last author, followed by a male first author with female last author; very few had both female first and last authors.

Given the low percentage of female neurointerventionists globally, which ranges in the single digits based on best estimates, the percentage of female authors in JNIS is high (up to 22.8% in 2020). This discrepancy in female representation in JNIS and the actual number of female neurointerventionists in practice is likely because not all articles with female involvement were written by female neurointerventionists. The majority of publications that contained female involvement were written by female first authors. There were few publications that contained a female last author. The designation of last author specifically refers to senior authorship. Senior authors are usually established female neurointerventionists with several years of experience and an academic rank who oversee the research. Unfortunately, in neurointerventional surgery, there are few female neurointerventionalists in an academic position. Such is also true for the comparative specialties of neurosurgery and radiology. Thus, low levels of senior female authorship is seen in comparable studies of major neurosurgery and radiology journals. First authorship, on the other hand, is reserved for the individual who makes the greatest contribution to the written piece. The female first authors of JNIS may be established female neurointerventionalists or they may be female medical students or resident trainees with an interest in neurointervention or research. This dearth of actively practicing female neurointerventionists in the current workforce may be a result of the many barriers that women historically faced when pursuing neurointerventional surgery.

A recent publication by Power et al explores the possible deterrents that women may encounter in their pursuit of neurointerventional surgery. One of the main barriers is that neurointerventional surgery is not traditionally seen as a profession that is friendly for women who wish to engage in childbearing. There is the added concern for radiation exposure to women of childbearing age, especially during pregnancy. Outside of the acute pregnancy interval, female interventionalists are more likely to report that they struggle with managing their domestic responsibilities with the long working hours that are expected of the field. As a result, a much greater proportion of male neurointerventionalists are married with children than women. Other barriers include gender-based discrimination and pay disparities that exist between men and women in neurointervention when it comes to leadership, academic titles, and research grants. While there is no difference in the number of men and women interested in holding a leadership position, there are far fewer women neurointerventionalists in supervisory roles. This leads to a lack of adequate female mentorship for young female neurointerventionalists at the start of their career, and hence to fewer female last authorship roles, as is reflected in this descriptive study.

In fact, the majority of publications with female contributorship consisted of original research articles as opposed to case reports, reviews or special topics. JNIS publishes more original research articles than any other article type, because original research topics contribute to the existing fund of knowledge in a novel, groundbreaking way. Original research articles are also what an author needs to publish for academic advancement, and publishing as a first author is something many women strive for in their quest to advance in this particular field, as is reflected in the highest female involvement as first authors in original research papers. Given the current landscape, it is encouraging to see that, over time, female authors did diversify their publication type. In 2020, more female authors wrote articles under the special topics category than ever before, and contributed more case reports and reviews, perhaps reflecting a rising number of women performing those type of procedures. However, somewhat disappointing is the lack of contribution of female authors to the technical video section.

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Traditionally, editor’s columns and editorial commentaries have mainly been written by men. However, in the later years, female first and last authors have contributed to these sections, albeit at a very low rate. This is important because editor’s columns and editorial commentaries are usually invited pieces by the editorial board. The contribution of female neurointerventionalists to these article types may suggest a growing acceptance of female authors and their work into the mainstream neurointerventional literature, and is aligned with the JNIS editorial commitment to support diversity. This is one of many efforts currently under way to recruit, advance, and retain women in male-dominated specialties.

The percentage of female involvement in JNIS publications was the highest in 2020. This was a unique year, in large part due to the fact that it was heavily marked by the COVID-19 pandemic. Similarly, the monthly issues of JNIS that were published in 2020 were different from the previous years. More articles were published under the category of special topics which included pieces on how the pandemic affected neurointervention. The COVID-19 pandemic may have played a role in the increased number of article types published. During the pandemic, there was an explosion in COVID-19 research.13 However, other types of health research such as basic science research and clinical research suffered due to an inability to perform the research due to strict social quarantine rules.14 As a result, there may have been a shift towards writing pieces that fell within the special topics category such as new devices and techniques and creating technical videos for submission. As for the effect on female authorship, there was concern that women’s research productivity would be disproportionately affected during the pandemic due to an increase in domestic responsibilities.15 Studies in the literature have reported a gender gap in the COVID-19 era publications.16 However, some journals have refuted the notion that female research output suffered as a result of COVID-19.17 Our assessment of the JNIS publications from the time of the pandemic which show an increase in the number of articles by female authors are consistent with the latter findings.

There are several limitations to our study. Our study is limited mainly by its small sample size and retrospective design. We were only able to collect data on 5 years’ worth of JNIS publications. Future works may include going back in time to assess how long this trend of increased female authorship has been in place. Additionally, the latter part of 2019 and all of 2020 was heavily impacted by the COVID-19 pandemic which may have confounded our observations in an unknown way. Lastly, in a small subset of authors, their gender was hard to deduce, which in the future will be alleviated by an improved submission process that marks gender-identifying questions.

CONCLUSION
In summary, the percentage of articles that had female contribution in the form of first or last author increased from 2016 to 2020. The trend was characterized as a steady increase over the 5 year period including during the COVID-19 pandemic, possibly indicating the growing role that female neurointerventionalists have begun to play in the discipline.

While much work remains to be done in order to address potential barriers and portray neurointerventional surgery as an attractive career option to women, the increase in female first authorship and the number of original research articles published show that the specialty is moving towards gender inclusivity similar to other competitive, traditionally male dominated specialties.

This analysis will serve as a benchmark to improve on over the years to come.

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