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Sex differences in authorship in cardiothoracic surgery during the early coronavirus disease 2019 pandemic



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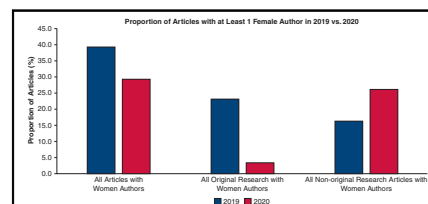
ABSTRACT

Objectives: The coronavirus disease 2019 (COVID-19) pandemic negatively impacted cardiothoracic (CT) surgery, with changes in clinical, academic, and personal responsibilities. We hypothesized that the pandemic may disproportionately impact female academic CT surgeons, accentuating preexisting sex disparities. This study assessed sex differences in authorship of 2 major CT surgery journals during the early part of the COVID-19 pandemic.

Methods: All accepted submissions to *The Annals of Thoracic Surgery* and *The Journal of Thoracic and Cardiovascular Surgery* between April and August of 2019 and the same period in 2020 were reviewed. Article type and author characteristics were obtained from the journals. Author sex was predicted using a validated multinational database (Genderize.io) and verified with authors' institutional and public professional profiles.

Results: In total, 1106 submissions were accepted during the 2019 period, whereas 900 articles (18.6% decrease) were accepted during the same period in 2020. Original research articles comprised 33.3% of the 2019 articles but only 4.9% of the 2020 articles. Female authors contributed to 39.3% (23.1% original research and 16.2% nonoriginal articles) and 29.4% (3.3% original research and 26.1% nonoriginal articles) of articles during the 2019 and 2020 periods, respectively. This represents a marked change in the type of articles that female authors contributed to.

Conclusions: Early on during the COVID-19 pandemic, the type of articles accepted, and authorship demographic changed. There was a decrease in contribution of female-authored CT surgery articles submitted to both journals, especially for original research. Future research will elucidate the long-term impact of the pandemic on sex disparities in academic productivity. (JTCVS Open 2022;11:265-71)



The proportion of original research with ≥ 1 female author declined from 2019 to 2020.

CENTRAL MESSAGE

Early in the COVID-19 pandemic, original research accepted to CT surgery journals declined whereas nonoriginal research articles increased. Original research with ≥ 1 female author also decreased.

PERSPECTIVE

During the first wave of the COVID-19 pandemic, academic productivity in CT surgery as measured by original research articles declined along with the proportion of original research with at ≥ 1 female author, thus accentuating pre-existing sex disparities. This study is the first to report sex differences in authorship specific to CT surgery journals during the first wave of the pandemic.

The coronavirus disease 2019 (COVID-19) pandemic negatively impacts cardiothoracic (CT) surgical care, with deferral of operations, particularly at the height of the pandemic waves, to allow for capacity to care for patients with COVID-19.^{1,2} The changes in clinical, academic,

and personal responsibilities as a result of the pandemic may disproportionately impact female academic surgeons to accentuate already-existing sex disparities in academia. Competing household, caregiver, and clinical duties exacerbated by the pandemic may be hindering female academic

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Abbreviations and Acronyms

| | |
|----------------------|---|
| <i>Ann Thor Surg</i> | = <i>The Annals of Thoracic Surgery</i> |
| COVID-19 | = coronavirus disease 2019 |
| CT | = cardiothoracic |
| <i>JTCVS</i> | = <i>The Journal of Thoracic and Cardiovascular Surgery</i> |

productivity, especially for early-career surgeons, relative to their male counterparts.³⁻⁶ A sex-specific effect of the current pandemic on female authorship has been described in various medical subspecialties and within COVID-19 research publications.^{3,7-9} A study of *JAMA Surgery* found a 4%, 6%, and 7% reduction in percentage of female first authors, last authors, and corresponding authors, respectively.¹⁰ However, the effect of the COVID-19 pandemic on authorship in CT surgery remains unknown.

This study aims to assess the impact of the first wave of the COVID-19 pandemic on sex differences in authorship of articles accepted for publication in 2 major CT surgery journals (*Video Abstract*). We hypothesized that academic productivity among female researchers in CT surgery during the early pandemic would be disproportionately lower than male counterparts compared with a similar period pre-pandemic as it relates to submissions to the 2 highest-impact factor CT surgery peer-review journals.

METHODS

Inclusion Criteria

All accepted articles to 2 major CT surgery journals—*The Journal of Thoracic and Cardiovascular Surgery (JTCVS)* and *The Annals of Thoracic Surgery (Ann Thor Surg)*—that were submitted between April 1 and August 31 of 2019 and the same period in 2020 (ie, the first wave of the COVID-19 pandemic) were reviewed. There were no exclusion criteria, and all accepted articles were included in the analysis.

Data Extraction

Variables readily available as part of the journals' electronic submission process for accepted articles, including submission dates, titles, and complete list of contributing authors, were obtained directly from the journals and reviewed. The following variables were manually harvested: (1) sex of all authors; (2) number of female authors; (3) type of article; (4) subspecialty category (adult cardiac, congenital, thoracic, education, or "other"); (5) region of origin of article; (6) number of authors; and (7) whether the article was presented at the American Association for Thoracic Surgery, Society of Thoracic Surgeons, Southern Thoracic Surgical Association, or Western Thoracic Surgical Association Annual Meetings. Primary research articles, conference proceedings, and clinical trials were considered original research, whereas nonoriginal research articles included editorials, case reports, reports, expert opinions, commentaries, letters to the editor, and review articles.

Author Sex Identification

Predicted author sex was obtained from the validated multinational database Genderize.io. Sex was assigned if Genderize.io predicted the sex at a probability $\geq 99\%$.¹¹ This threshold is greater than previously

used in other similar studies.⁷ If there was any uncertainty, a manual review of publicly available institutional websites or [ctsnet.org](https://pubs.ctsnet.org) was done to confirm an author's sex and their self-identifying pronouns. Lastly, if not found on these platforms, an author's public and professional LinkedIn or ResearchGate profiles were reviewed. A small proportion of authors' sexes was unable to be identified (3.7% in 2019 and 2.7% in 2020). These authors were categorized as "unknown" in the analysis.

Statistical Analysis

Summary statistics were used to describe and compare accepted article characteristics and authorship for articles submitted to *JTCVS* and *Ann Thor Surg* during April 1 to August 31, 2019, to those submitted during April 1 to August 31, 2020.

RESULTS

Article Characteristics

A total of 1106 articles and 900 articles were accepted to *JTCVS* and *Ann Thor Surg* between April 1 and August 31 of 2019 and 2020, respectively (*Table 1*). There was a shift in the type of articles accepted from 2019 to 2020, with a decrease in original research (from 33.3% to 4.9%) and an increase in nonoriginal research articles (from 66.7% to 95.1%), especially editorials, during the early pandemic period (*Figure 1*). Education-focused articles also increased in proportion from 4.3% in 2019 to 7.4% in 2020. In addition, the proportion of adult cardiac, congenital, and general thoracic subspecialty articles were similar between 2019 and 2020, with adult cardiac making up most of both years. Furthermore, the number of original research articles promptly declined in April 2020 and continued declining to 0 accepted articles by August 2020. Conversely, nonoriginal articles were increasingly accepted for publication in April and May of 2020 (*Table 2*).

Articles With Female Authors

Among articles accepted to *JTCVS* and *Ann Thor Surg* between April 1 and August 31 of 2020 as compared with the same period in 2019, there was a decline in the proportion of articles that included at least one female author, relative to those with all male authors (*Figure 2*). The proportion of accepted article that included at least 1 female author fell from 39.3% in 2019 to 29.4% in 2020. The greatest area of decline was in original research articles, for which the proportion with at least 1 female author declined from 23.1% in 2019 to 3.3% in 2020 (a reduction of 85.6%). In contrast, female authorship for nonoriginal articles increased from 16.2% in 2019 to 26.1% in 2020. Not only did the representation of female authors fall from 2019 to 2020, but also there was a marked change in the type of articles they authored.

When assessed by month, the decline in proportion of articles with at least 1 female author was observed early in the pandemic in April 2020 at 31.1% and worsened thereafter to 20.8% by August 2020 (*Figure 3*).

TABLE 1. Article characteristics

| Article characteristics | 2019 (n = 1106) n (%) | 2020 (n = 900) n (%) |
|---|-----------------------|----------------------|
| Total number of publications (n = 2006) | 1106 (55.1) | 900 (44.9) |
| Total original research articles | 368 (33.3) | 44 (4.9) |
| Conference proceedings | 127 (11.5) | 3 (0.3) |
| Primary research articles | 238 (21.5) | 41 (4.6) |
| Clinical trials | 3 (0.3) | 0 (0.0) |
| Total nonoriginal articles | 738 (66.7) | 856 (95.1) |
| Reports | 12 (1.1) | 9 (1.0) |
| Case reports | 78 (7.1) | 75 (8.3) |
| Review articles | 11 (1.0) | 13 (1.4) |
| Editorials | 527 (47.6) | 690 (76.7) |
| Expert opinions | 110 (9.9) | 69 (7.7) |
| Subspecialty | | |
| Adult cardiac | 615 (55.6) | 473 (52.6) |
| General thoracic | 253 (22.9) | 189 (21.0) |
| Congenital | 157 (14.2) | 115 (12.8) |
| Education | 48 (4.3) | 67 (7.4) |
| Other | 33 (3.0) | 56 (6.2) |

From April 1 to August 31, 2019, to the same period in 2020, there was an 85.3% reduction in the proportion of original research articles, with a 61.1% increase in the proportion of editorial articles accepted for publication.

Article Geographical Distribution

Representation of female authors in articles submitted to *JTCVS* and *Ann Thor Surg* varied by geographical area of origin (Figure 4). The top 3 geographical regions contributing to the 39.3% of articles accepted with at least 1 female author in 2019 were as follows: North America (70.3% of the 2019 articles with at least female authors), Europe, and Asia. Conversely, the 29.4% of articles

accepted with at least 1 female author in 2020 originated from the following top 3 regions: North America (78.1% of the 2020 articles with at least female authors), Europe, and Asia. The proportion of articles with at least 1 female author declined worldwide. Of note, CT surgeons from North America contributed the most to the female author representation and experienced the greatest decline in proportion from 2019 to 2020.

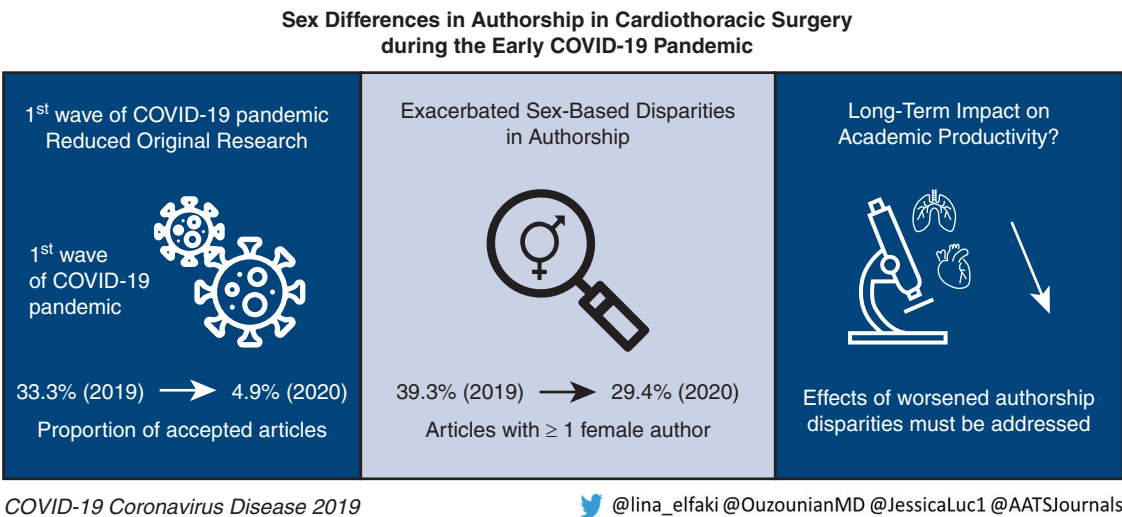


FIGURE 1. Sex differences in authorship of the 2 highest-impact CT surgery journals. Early in the COVID-19 pandemic (April to August of 2020), there was a change in the type of articles accepted and the authorship demographic, relative to the same period in 2019. Original research articles accepted to CT surgery journals declined, whereas nonoriginal articles increased. Female authors contributed more to nonoriginal articles and less to original articles during the pandemic. CT, Cardiothoracic; COVID-19, coronavirus disease 2019.

TABLE 2. Trend of accepted articles per month

| Number of papers by month, n | 2019 | 2020 |
|----------------------------------|------|------|
| Total original research articles | 368 | 44 |
| April | 70 | 27 |
| May | 118 | 14 |
| June | 79 | 3 |
| July | 56 | 0 |
| August | 45 | 0 |
| Total nonoriginal articles | 738 | 856 |
| April | 133 | 243 |
| May | 142 | 187 |
| June | 126 | 163 |
| July | 172 | 143 |
| August | 165 | 120 |

The number of accepted original research articles declined significantly from April to August of 2020, whereas nonoriginal articles were increasingly accepted in the first few months of the pandemic.

Authorship Position

During the first wave of the pandemic, the absolute number of female authors submitting to *JTCVS* and *Ann Thor Surg* decreased from 825 to 411, along with a decrease in the female first and last authors from 165 to 148 and 107 to 100, respectively. As a percentage of total authorship, the proportion of female authors dropped from 16.1% to 15.7% from 2019 to the same period in 2020. Conversely, as a percentage of total first authors, the proportion of female first authors increased from 14.9% to 16.4%. The proportion of female last authors similarly increased from 9.7% to 11.1% during the first wave of the pandemic. While the proportion of total female authors decreased,

the representation of female authors as first and last authors increased from 2019 to 2020.

COMMENT

Our study demonstrates that there was a change in type of articles and authorship among articles accepted for publication in the *JTCVS* and *Ann Thor Surg* journals during the early COVID-19 pandemic. Not only did the total number of articles accepted during the period of April 1 to August 31, 2019, fall by 18.62% compared with the same period in 2020, but there was also a marked shift away from primary research articles and toward editorial articles. This may be reflective of the temporary closure of most research laboratories and change in clinical and personal responsibilities that many clinician- and surgeon-scientists experienced, especially early in the pandemic.⁵ In addition, research funding and priorities shifted worldwide and, similarly, within the field of CT surgery. In the midst of the unknown, editorials reflecting on pandemic-related challenges and effective ways to navigate them informed the focus of many CT surgery articles. In the first months of the pandemic, CT surgery academic journals were also more interested in publishing articles that appealed to pandemic-related findings, which took time to uncover. Original research studies, including clinical trials, that is, specific to clinician training, education, and patient care, were being set in motion during the first wave. Therefore, in the first few months of the pandemic, a marked decline in original research was accepted for publication. This decline was apparent in April and reached 0 original research articles accepted by August of 2020.

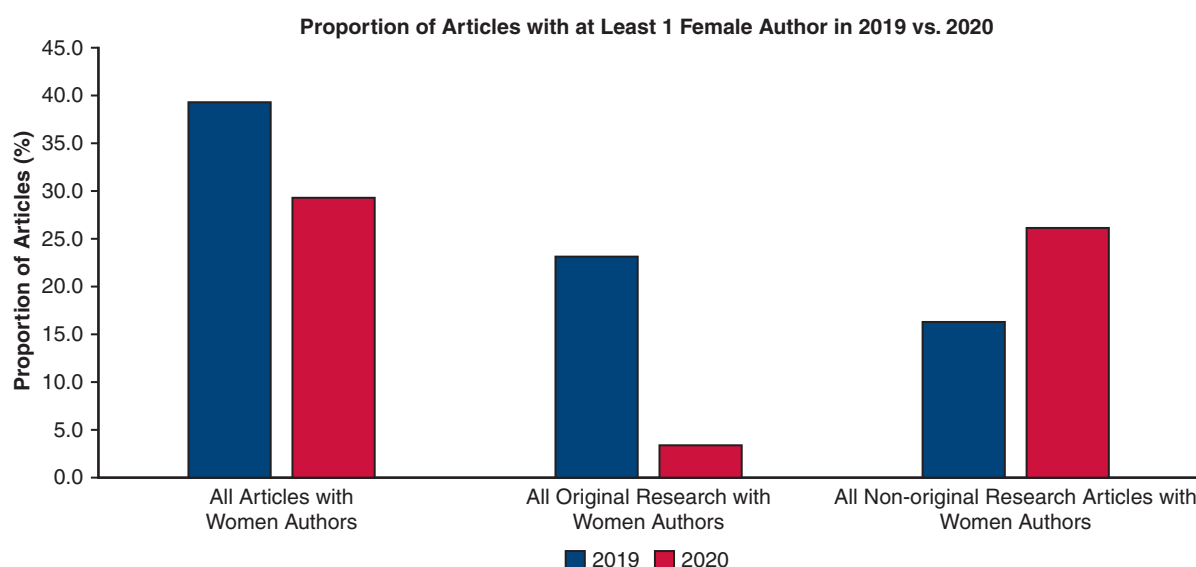


FIGURE 2. Proportion of articles with at least 1 female author in 2019 versus 2020. From 2019 to 2020, there was a change in quantity and type of articles that were authored by female authors. The proportion of articles with at least 1 female author declined, driven by a decline in the proportion of original research articles authored by females.

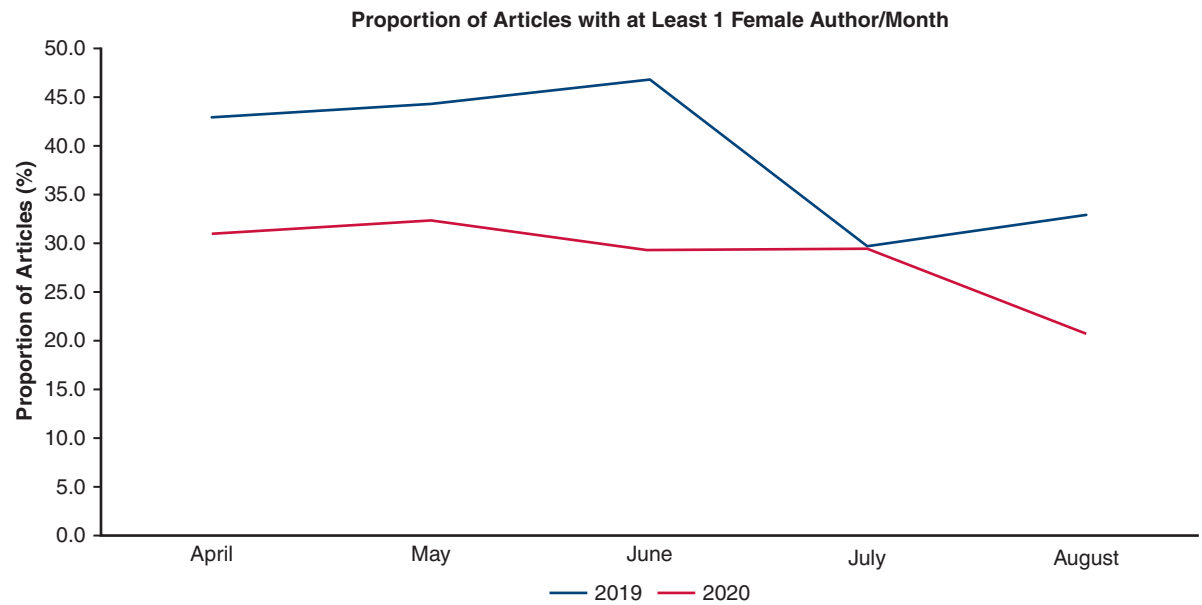


FIGURE 3. Proportion of articles with at least 1 female author/month. A marked decrease in the proportion of articles with at least 1 female author was noted in April 2020, which worsened until August 2020, relative to the 2019 numbers.

At the time of this writing, the COVID-19 pandemic is still ongoing. It has been reported that the pandemic affects women and men differently. We demonstrate a marked reduction in the total number of articles that included at least 1 female author, particularly in the proportion of original research articles that dropped by 85.6% in the pandemic period. This strengthens the worrisome finding that Dr Kibbe reported of decreased female authorship in *JAMA Surgery*.¹⁰ There are many postulated causes for these observations. Despite an increase in representation

in the CT surgical workforce over the years, the pandemic may amplify the already-existing sex-based inequities in academic productivity that adversely impact female surgeons.^{5,10,12,13} During the pandemic, it is possible that there is a disproportionate increase in household, caregiver duties, and burnout that contributed to a decrease in female research productivity and authorship.¹⁰ In addition to shifting demands, other studies have reported sex disparities in COVID-19–related research and pandemic leadership, with fewer women in these roles.^{5,12,14} Further research is

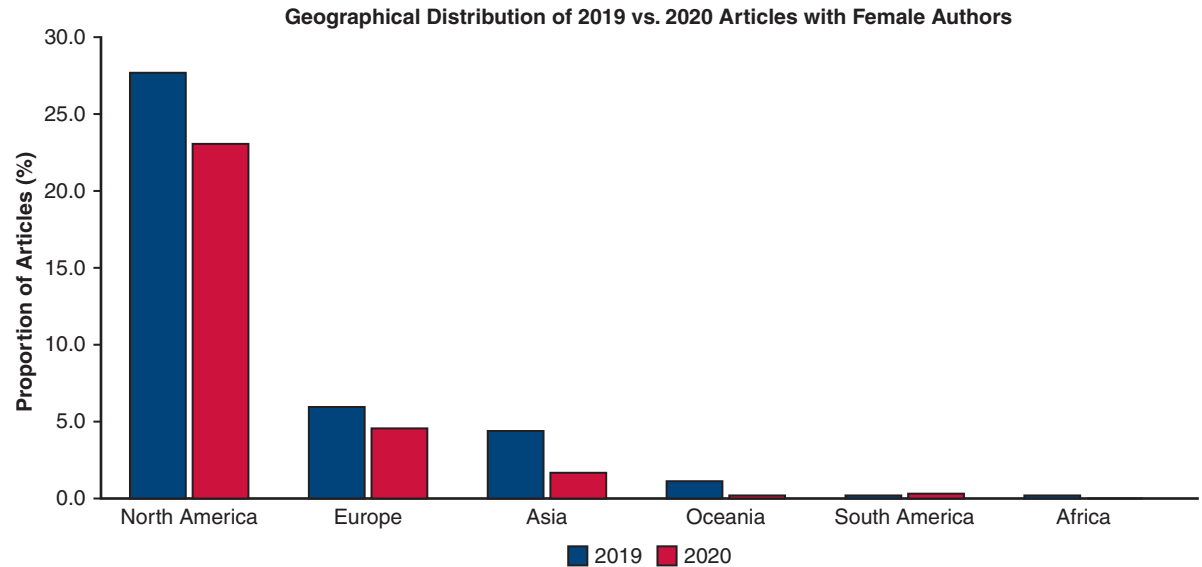


FIGURE 4. Geographical distribution of articles with female authors. Across all continents, the proportion of articles with at least 1 female author has decreased from 2019 to 2020.

needed to elucidate the causes that are specifically relevant to CT surgery literature.

We also observed that the decline in representation of female authorship in CT surgery articles transpassed geographical boundaries and their pandemic responses. In each of the geographical regions of highest academic productivity, from North America to Europe to Asia, there was a marked reduction in the proportion of articles with female authors. Therefore, although there may be unique cultural, political, and geographical challenges, female researchers experienced a heightened shift in responsibilities and academic regression worldwide. Furthermore, the low number and proportion of female authors outside of North America and Europe before and during the pandemic calls for international efforts to make the field more inclusive worldwide. Although our study focuses on CT surgery research, these findings similarly apply to worldwide COVID-19 research in all medical subspecialties.^{3,5} However, it is important to highlight that the genderize.io algorithm has been found to have compromised accuracy when it comes to names of non-European origins, necessitating future research that uses other methods of author sex identification.¹⁵

Interestingly, although the absolute number of female authors and the proportion of manuscripts with any female author declined substantially during the first wave of the pandemic, the proportion of female authors as first and last authors increased from 2019 to 2020. Although the proportion remained less than 20%, we observed a slight year over year increase during the pandemic, possibly reflecting trends established before COVID-19. This aligns with a recent bibliometric analysis of high-impact cardiology journals that reported a similar increase in the relative proportion of female first and last authors.⁷

Our data suggest that there may be systematic challenges that disproportionately impact female academic productivity during the pandemic. These should be considered when assessing academic merit and suggest that ongoing work is needed at the interpersonal, institutional, and overall specialty level to foster a more inclusive and just culture for all underrepresented groups in CT surgery.^{14,16} We highlight that during the pandemic, the proportion of original research articles declined, whereas nonoriginal research articles, particular editorials, increased. Ongoing efforts to improve equity in research opportunities, tenure and promotional considerations, work hours and clinical responsibility divisions, and grant funding are required to promote and maintain diversity in CT surgery.^{12,17}

Study Limitations

Our study is subject to a number of limitations that should be considered when interpreting its findings. First, we only evaluated 2 major CT journals, *JTCVS* and *Ann Thor Surg*.

It remains unknown whether our results apply to other surgical specialty journals. Second, it is important for us to acknowledge that we assumed a binary sex system in our study methodology and were limited by the accuracy of the genderize.io algorithm. Name-based sex identification has been used widely to identify disparities in research productivity during the pandemic. A bibliometric analysis of cardiology journals along with another recently published study uncovering sex-based disparities in COVID-19 clinical trial leadership used genderize.io.¹⁸ A study exploring various medical specialties used an equivalent algorithm, Gender API.^{3,7} There may be regional variability in the identification of author sex with regards to the accuracy of the genderize.io API. The algorithm, while found to be more accurate than country censuses or birth name lists, carries a misclassification rate of <2% when retaining a classification label for $\geq 75\%$. Its inaccuracy is especially apparent in names of non-European origin.¹⁵ To minimize this, we used a high threshold of probability of accuracy $\geq 99\%$, a threshold greater than previously used in other similar studies.^{7,11} In addition, further attempts were made to verify the authors' sex manually through a search of their public and professional institutional or academic profiles when they did not meet this high threshold.

Third, as our goal was to assess the early impact of the pandemic on academic productivity, our study was limited to the period of April to August in 2019 and 2020, and it provides a snapshot in time of a continuously evolving situation with regional differences and responses to burden of impact. As such, the true impact of the overall pandemic remains to be determined. Importantly, accepted articles were used as a surrogate of academic productivity, although we recognize that there are many other forms of academic productivity that remain uncaptured in this study, including manuscripts that were submitted to the study journals, rejected, and presumably went on to be accepted in another journal. Furthermore, there is a known delay in conducting research, writing a manuscript, and submitting for publication; as such, the results presented herein may be a reflection of the work months prior and do not precisely reflect the burdens of the first few weeks of the pandemic. Due to confidentiality concerns, we were unable to obtain the total number of manuscripts submitted during this time period and could only report manuscripts that were accepted. We were also unable to categorize original research articles into clinical, basic science, or translational and are thus unable to identify disparities in research productivity in these specific areas.

CONCLUSIONS

During the early pandemic, there was a change in the type of articles accepted and authorship demographic to 2 prominent CT journals—*JTCVS* and *Ann Thor Surg*. Within and beyond North America, there was a decrease in female

authorship within CT surgery articles. Future studies are needed to further elucidate the long-term impact of the pandemic on sex disparities in academic productivity. This will have implications for subsequent pandemics, as it highlights the need for targeted approaches to promote inclusive research opportunities and productivity within the academic CT surgery community. Further research is needed in determining why these disparities occurred and whether specific areas of original research were disproportionately affected.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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Key Words: equity, diversity, scholarship, COVID-19, women in surgery