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## The impact of COVID-19 on the gender distribution of emergency medicine journal authors



COVID-19 has had a profound effect both through the impact of the disease, as well as resultant closures, economic instability, and increased workload placed on physicians. Physician gender inequality regarding unpaid domestic work has been well-established, [1,2] and has worsened during the COVID-19 pandemic [3]. Likely further compounded by the loss of in-person connectivity, with one recent study showing decreased research benefit via social media for women [4].

In academic medicine, research and publishing are directly tied to promotion and career advancement. However, there remains a gender gap in publications within Emergency Medicine (EM). In 2007, 24% of first authors were female [5], increasing to 30% in 2019 [6]. Publications are also an important factor in promotion and tenure, and having diverse authors is important for all specialties. The goal of this project was to compare the gender distribution of first, last, and total authors before and during the COVID-19 pandemic.

We performed a cross-sectional study of the gender distribution of publication authors before and during COVID-19. We adhered to the strengthening the reporting of observational studies in epidemiology guidelines [7]. This study was deemed exempt by the institutional review board at [blinded]. We compiled a list of all articles published in the *Annals of Emergency Medicine (Annals)* and *Academic Emergency Medicine (AEM)* from March 2019 to February 2021, representing two EM journals with high impact factor. The journals were separated into pre-pandemic (March 2019–February 2020) and peri-pandemic (March 2020–February 2021). We included all issues except for the annual scientific assembly issue.

We developed a data extraction tool to identify and categorize the gender of the authors. We piloted the tool independently and modified it in accordance with the pilot. All investigators were trained on the use of the data extraction tool. Investigators independently obtained the following data using publicly accessible information: month and year of publication, article title, number of authors, and gender of each author. We utilized the Genderize™ program (<https://www.genderize.io>) to determine author gender consistent with prior research [6,8]. When the probability was <0.90, we reviewed the author's faculty profiles and utilized the gender pronouns used in their biographies. When a faculty profile was not available or no pronoun was listed, we listed the gender as unknown.

Descriptive statistics evaluated the average count of authors based on gender and author position. A Chi-squared analysis compared the count of male versus female total authors and the count of male, female, and unknown first and last authors for the pre-COVID-19 year versus the peri-COVID-19 year. Descriptive and non-parametric statistics were computed using IBM SPSS Version 26 (IBM Corp; Armonk, NY)

and Chi-Square Test Calculator (<https://www.socscistatistics.com/tests/chisquare2/default.aspx>).

We reviewed 1162 articles with 5828 authors. Of these, 445 articles were from *AEM* and 717 were from *Annals*. Out of the 5828 total authors, 1935 (33.2%) were female, 3668 (62.9%) were male, and 225 (3.9%) were unknown gender. Among first authors ( $n = 1162$ ), 355 (30.6%) were female, 765 (65.8%) were male, and 42 (3.6%) were unknown. Among last authors ( $n = 1019$ ), 231 (22.7%) were female, 749 (73.5%) were male, and 39 (3.8%) were unknown. A Chi-squared analysis of all articles revealed a significant difference between the distribution of female and male authors overall ( $X^2_1 = 457$ ), first ( $X^2_2 = 678$ ) and last authors ( $X^2_2 = 794$ ). However, there was no difference in this overall pattern when comparing pre-COVID-19 to the peri-COVID-19 data (Table 1). Fig. 1 demonstrates the trend of gender distribution of first and last authors over time.

To our knowledge, this is the first study to assess the effect of the COVID-19 pandemic on the gender distribution of authors in EM. Overall, we found that a gender gap was present among publications, however this does not appear to be impacted by COVID-19. In our study, we found that 30.6% of first authors were female, which is consistent with other data [6]. Interestingly, the gender disparity was more prominent among last authors, where female authors comprised only 22.7%. The last author position is often more highly valued by promotion and tenure committees, this highlights a need to increase gender equity across authorship, with an emphasis on first and last author positions.

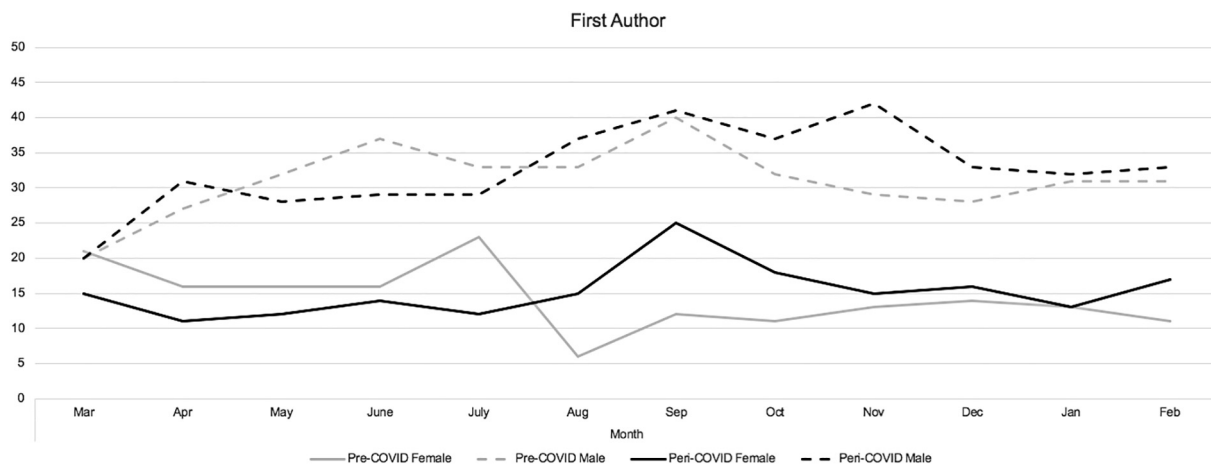
Surprisingly, we did not identify a difference in gender distribution of total, first, or last authors when comparing pre-COVID-19 with peri-COVID-19 publications. One study comparing COVID-19 specific papers versus papers from 2019 reported a 19% reduction in the proportion of female first authors [9]. However, this study included multiple fields

**Table 1**

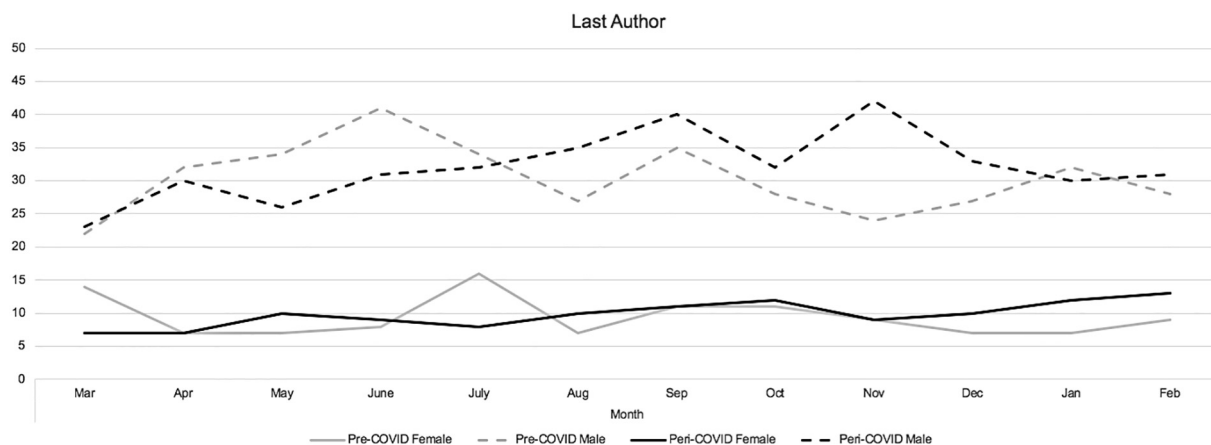
Gender Distribution of all authors in *Annals of Emergency Medicine* and *Academic Emergency Medicine* comparing pre-COVID-19 (March 2019 to February 2020) and peri-COVID-19 (March 2020 to February 2021).

	Pre-COVID-19 Authors (%)	Peri-COVID-19 Authors (%)	Chi-squared comparing Pre-COVID-19 to Peri-COVID-19
<b>First Author</b>			
Female	172 (30.2%)	183 (30.9%)	$X^2_2 = 1.2$
Male	373 (65.6%)	392 (66.1%)	
Unknown	24 (4.2%)	18 (3.0%)	
<b>Last Author*</b>			
Female	113 (22.6%)	118 (22.8%)	$X^2_2 = 2.5$
Male	364 (72.7%)	385 (74.3%)	
Unknown	24 (4.8%)	15 (2.9%)	
<b>Total Authors</b>			
Female	891 (32.1%)	1044 (34.2%)	$X^2_2 = 4$
Male	1765 (63.6%)	1903 (62.3%)	
Unknown	117 (4.2%)	108 (3.5%)	

\* When a manuscript has only one author, they were classified as first author and no last author was counted.



**Fig. 1.** Gender distribution of first authors. The fig. Depicts the gender distribution of all first authors in *Annals of Emergency Medicine* and *Academic Emergency Medicine* from March 2019 to February 2020 (pre-COVID-19), and March 2020–February 2021 (peri-COVID-19). Fig. 1b Gender distribution of last authors. The fig. Depicts the gender distribution of all last authors in *Annals of Emergency Medicine* and *Academic Emergency Medicine* from March 2019 to February 2020 (pre-COVID-19), and March 2020–February 2021 (peri-COVID-19).



**Fig. 1 (continued).**

with EM comprising only 54 COVID-19 publications. Another study of publications from January to April 2020 reported that the gender gap increased two-fold in medRxiv, while there was no difference in bioRxiv [10]. It is possible that the impact of COVID-19 may have a more delayed impact which will take years to fully present.

This study has several limitations. First, gender is non-binary and self-determined. We defined gender using Genderize™, which is an on-line platform that has been previously utilized for this [6,8]. While we only utilized this when the probability was >0.90 and used faculty profiles for all other cases. Genderize™ have miscategorized some authors as it relies on first names rather than directly surveying the authors themselves, which would not have been feasible. We utilized a four-month time delay to account for time to publication. However, given the time required for many studies to get published, it is possible that this may have been too soon to see the full impact on gender representation in publications. Finally, we selected only the top two journals in EM. It is not known if the findings reflect other journals in EM or in other fields.

While the full impact of COVID-19 on gender equality may not be known for many years, we found no statistically significant difference among first, last, and total authors between the pre-COVID-19 and peri-COVID-19 time periods. Future research should assess the delayed impact of COVID-19 on publications and academic promotion.

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All authors report no prior presentations.

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