

Meta-Research: Is Covid-19 Amplifying the Authorship Gender Gap in the Medical Literature?

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Abstract: The COVID-19 pandemic has affected work and family life for many, including academic researchers. Anecdotal evidence suggests that university shutdowns have influenced the article submission rates of men and women differently. Here we present a timely analysis that compares the proportion of men and women medical researchers publishing on the coronavirus to those publishing in the same journals in 2019. This is presently the most direct means of gauging gender variations in ongoing research activities. For clarity of context, we delimit our analysis to researchers in the United States. Using mixed-effects regression models, we estimate that women's shares of first authorships, last authorships and general representation per author group are 23%, 16% and 16% lower for COVID-19 papers compared to 2019 papers published in the same journals. Our findings are consistent with the idea that the research productivity of women, especially early-career women, is being affected more than the research productivity of men.

Introduction

During the COVID-19 pandemic, many governments have shuttered schools and implemented social distancing requirements that limit options for childcare, while simultaneously requiring researchers to work from home (Minello, 2020). Robust evidence suggests that women in academic medicine shoulder more of the burden of domestic labor within their households than do men. One study of an elite sample of NIH-funded physician-researchers showed that women spent 8.5 hours more per week on parenting and domestic tasks than their men peers (Jolly et al., 2014). Recent research also suggests that women in academia take on more domestic responsibilities than men, even in dual-career academic couples (Derrick et al., 2019). Therefore, the recent restrictions in access to childcare might reasonably be expected to have disproportionate impact on women in academic medicine, as compared to men. The impact of new professional service demands that now compete with time for scholarly productivity in academic medicine, including restructuring of teaching and clinical care using virtual platforms, may also disproportionately impact women medical researchers, who are disproportionately represented on clinician-educator tracks .

Here, we focus on the published medical research literature, where it may be possible to provide an early evaluation of whether the gender gap in academic productivity is widening. The medical literature now includes a substantial number of articles directly relating to COVID-19, mostly generated rapidly after the broader social restrictions came into being, in most US states, in March 2020. Therefore, we report the results of a global analysis of possible variations in women's proportion of authorships of articles on COVID-19 ($N = 9,050$), as compared to the proportion of women among authorships of all articles

published in the same journals the previous year ($N = 193,098$). Specifically, we used mixed logit and tobit models with scientific journal as random effect parameter, to estimate women's share of first authorships (logit), last authorships (logit) and proportional representation per article (tobit), for Covid-19 papers (treatment) and papers published in the same journals in 2019 (control).

Results

Panels a, b and c (figure 1) juxtapose the observed proportion of women authorships (bars) for COVID-19 papers and for papers published in the same journals in 2019. This descriptive analysis suggests that the proportion of women publishing as first authors and last authors has decreased by 23% and 12%, respectively, after the outbreak of the Pandemic (COVID-19 sample: first authorships, arithmetic mean= 0.28; last authorships, arithmetic mean: 0.23; 2019 sample: first authorships, arithmetic mean= 0.36; last authorships, arithmetic mean: 0.26), while the overall share of women per author group has decreased by 11% (COVID-19 sample: arithmetic mean= 0.30; 2019 sample: arithmetic mean= 0.34).

The crosses and error-bars in figure 1 (panels a and b) plot the adjusted means derived from the mixed logit models that control for variations in COVID-19 related research activities across scientific journals and show that women's estimated share of first authorships and last authorships is 23% and 16% lower in the COVID-19 sample (first authorships, adjusted mean= 0.28, CI: 0.25-0.31; last authorships, adjusted mean: 0.22, CI: 0.20-0.25) compared to the 2019 sample (first authorships, adjusted mean: 0.37, CI: 0.35-0.38; last authorships, adjusted mean: 0.27, CI: 0.25-0.28). Likewise, the outcomes of the mixed tobit model, plotted in panel c (figure 1), indicate that women's estimated general representation per article is 16% lower in the COVID-19 sample (adjusted mean: 0.30, CI: 0.27-0.32) compared to the 2019 sample (adjusted mean: 0.35, CI: 0.34-0.37) (see Figure 1- source data 1 to 3 for model specifications).

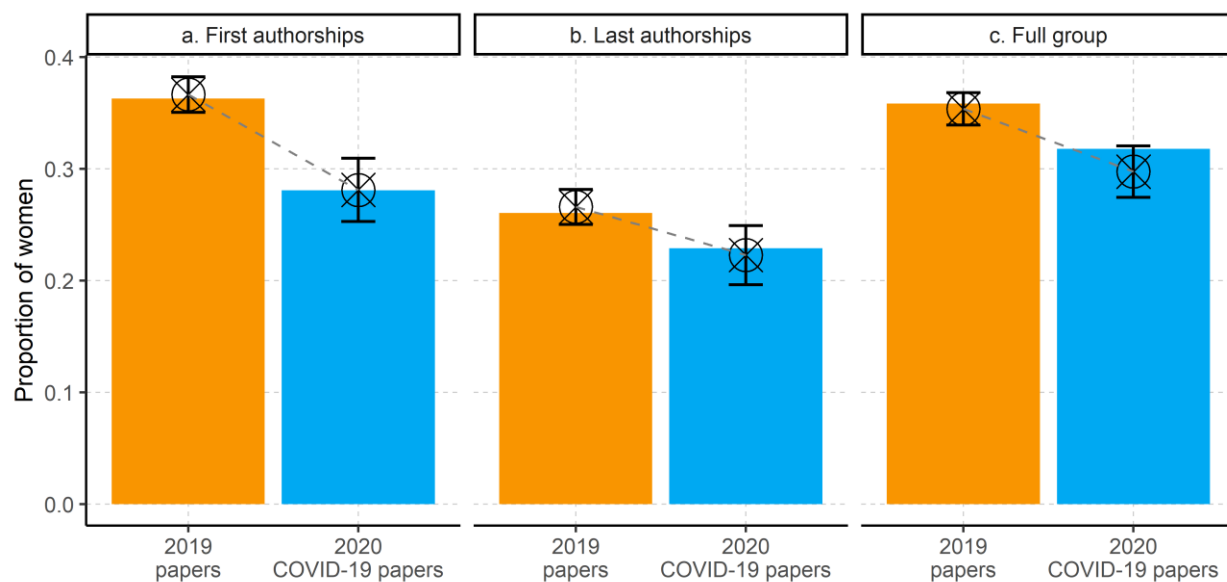


Figure 1: Observed (bars) and estimated (crosses and error-bars) proportions of women among authors of 1,179 U.S. papers on COVID-19 and 37,531 papers published in the same journals in 2019. The bars show differences in the observed proportions of women in different author positions (a and b) and for the complete author list (c), for papers published in 2020 COVID-19 papers (blue bars) versus papers from the same journals in 2019 (orange bars). All three panels show a decrease in the observed proportion of women. The crosses and error-bars laid over the bars report the adjusted means and 95% confidence intervals derived from mixed logit and tobit models with scientific journal as random effect parameter.

To obtain a closer approximation of differences across research areas, we calculated the proportion of women authorships per journal specialty. As shown in Table 1, women are represented at lower rates across most specialty groupings in the COVID-19 sample as compared to the 2019 sample. The relative gap in women’s participation is most salient in infectious diseases, radiology, pathology, and public health. Importantly, none of these groups show extreme deviations variations from the overall trend. This indicates that the observed differences are not due to a specialty bias, where specialties with a high representation of men produce the majority of COVID-19 research.

<i>Journal specialty</i>	2019 papers				COVID-19 papers			
	<i>N</i>	Proportion of women			<i>N</i>	Proportion of women		
		<i>First author</i>	<i>Full group</i>	<i>Last author</i>		<i>First author</i>	<i>Full group</i>	<i>Last author</i>
Dermatology	582	0.45	0.47	0.37	46	0.35	0.41	0.28
Emergency medicine	786	0.34	0.33	0.23	41	0.29	0.29	0.15
High impact general medicine	949	0.35	0.40	0.32	101	0.33	0.39	0.37
Infectious diseases	670	0.47	0.43	0.29	41	0.17	0.30	0.24
Internal medicine	8,266	0.36	0.35	0.26	294	0.30	0.31	0.18
Other basic sciences	8,948	0.37	0.35	0.25	106	0.26	0.31	0.25
Other clinical sciences	9,040	0.39	0.39	0.30	257	0.33	0.34	0.28
Other health professions	110	0.51	0.54	0.42	7	0.43	0.49	0.43
Otolaryngology	904	0.32	0.29	0.19	74	0.19	0.27	0.20
Pathology	325	0.42	0.44	0.31	31	0.23	0.33	0.32
Public health	2,173	0.44	0.42	0.32	53	0.23	0.33	0.23
Radiology	1,209	0.32	0.32	0.24	39	0.18	0.29	0.08
Surgery	3,569	0.23	0.23	0.13	89	0.22	0.20	0.11

Table 1. Number of observations, *N*, and proportion of women by author list position for journals grouped by their specialty. The grouped columns show results by journal category for COVID papers published in 2020 (four rightmost columns) in contrast to papers from the same journals in 2019. Only papers with at least one US address in the affiliations and clear gender for first and last author are included.

Discussion

Prior research has raised concerns about women’s underrepresentation among authors of medical research, including both original research and commentaries (Clark et al., 2017; Hart and Perlis, 2019; Jagsi et al., 2006; Larson et al., 2019; Silver et al., 2018). Our analysis suggests that the COVID-19 pandemic may be amplifying this gender gap in the medical literature. Specifically, we find that women constitute a lower proportion of authors of articles on COVID-19, as compared to the proportion of women among authors of all articles published in the same journals the previous year. The difference in women’s participation before and after the pandemic is most striking for first authorships. This finding is consistent with the idea that restricted access to child-care and increased work-related service demands might take the greatest toll on early-career women, although our observational data cannot conclusively support causal claims. As more robust evidence becomes available, mechanisms which disadvantage specific ethnic, age and gender groups should be monitored and inform policies that promote equity (Donald, 2020).

Some have argued that the authorship gender gap in academic medicine is best explained by a slow pipeline and the historical exclusion of women from medical school enrollment¹. However, as time has passed, and women have reached parity in the United States and even begun to constitute the majority of the medical student body in many other countries, their persistently low participation as authors has raised concerns about bias in unblinded peer review processes and unequal opportunities prior to manuscript submission (Jagsi et al., 2014; Silver, 2019). Studies have demonstrated differences in the very language used by men and women to describe their research findings (Lerchenmueller et al., 2019), and evidence suggests that women's writing may be held to higher standards (Hengel, 2017). In any case, the current study suggest that if authorship of COVID-19-related papers is a bellwether, women's participation in the medical research literature may now be facing even greater challenges than before the pandemic, especially if ongoing or repeated episodes of social distancing are required as expected (Kissler et al., 2020).

This study is limited to a relatively small sample produced early in the course of the pandemic and misses information on important covariates. However, descriptive analysis that breaks down our results by specialty does not suggest that those specialties that might dominate research related to COVID had low proportions of women among authors in 2019. Indeed, many such specialties, including infectious disease and public health, qualitatively appear to have a markedly lower proportion of women among authors in the 2020 COVID-related dataset than in the 2019 dataset within those fields. Therefore, despite limitations, this early look suggests that the previously documented gender gap in academic medical publishing may warrant renewed attention (Jagsi et al., 2006) and that ongoing research on this subject is necessary as more data become available.

Although some may believe that diversity and equity are niceties that cannot be considered during times of crisis, abundant literature reveals the importance of diverse teams for solving complex problems like those related to COVID-19 (Nielsen et al., 2018, 2017; Phillips et al., 2014; Woolley et al., 2010). If societal constraints limit the talent pool who may contribute to research informing the crisis response, the consequences will be profound indeed. Policies to support full inclusion of diverse scholars and transformation of norms for dividing labor appear to be urgent priorities.

¹ Association of American Medical Colleges. Medical students, selected years, 1965-2013, 2019. Available: http://www.aamc.org/download/411782/data/2014_table1.pdf.

Materials & methods

On May 9th 2020, we searched PubMed Medline for papers including “COVID-19” or “SARS-CoV2” in the title or abstract, to identify publications most likely generated after pandemic-related societal changes developed. This resulted in 9,054 articles, of which only 4 were published prior to 2020. We extracted journal information and matched the 2020 papers [treatment] to 2019 papers [control] from the same journals ($N = 193,098$). Only journals with at least 5 papers on COVID-19 were included in the analysis (443 of 1,823 journals (24.3%), 6,734 of 9,050 papers (74.4%)). We extracted author names for both treatment and control, and used these to determine author gender as in prior work (Andersen et al., 2019). Gender was reliably estimated for 81.9% of the entire sample. For the papers with at least one US author, gender could be established for 89.4% of first authors and 90.5% of last authors. Only papers with gender reliably identified for first and last authors were included. Limiting the sample further to papers with at least one author with a US address, with gender determined for authors, gives us a treatment group of 1,179 papers (13.0%) and a control group of 37,531 papers (19.4%). The treatment group is relatively smaller, because proportionally more COVID-19 research has been done by researchers outside the US, especially those in China and Italy.

As a robustness check, we selected a random sample of 300 publications from the treatment group and looked up information supplied by the publishers on submission and publication dates. Far from all publishers offer this information and to our knowledge there are no databases gathering this information consistently. Thus, we were able to find submission dates for 153 (51.0%) of the 300 publications. Of these, 129 (84.3%) were submitted after March 15th, 2020, and 276 of the 300 (92.0%) were published after this date.

We calculated the general proportion of women per author group (f_share) for all papers included in the analysis. If we could not determine the gender of one or more authors, these were left out of the equation, so as to not skew the average share towards one gender. f_share values range from 0 to 1, with values closer to 1 indicating a higher proportion of women in the paper’s byline.

We used mixed logit and tobit models to estimate women’s share of authorships Covid-19 papers (treatment) and papers published in the same journals in 2019 (control). We included scientific journal as random effect parameter to adjust for variations in COVID-related research activities across scientific journals.

The mixed tobit regression was used to estimate the relationship between the dichotomous intervention variable (2019 sample=0, COVID-19 sample=1) and women's overall representation per article (f_share). The tobit model was specified with a left-censoring at 0 and a right-censoring at 1, and computed with robust standard errors. We used multilevel logistic regressions to estimate the relationship between the intervention variable and women's share of first authorships (outcome variable: man=0, woman=1) and last authorships (outcome variable: man=0, woman=1). The statistical analyses were conducted in STATA 16 and R version 4.0.0. For the multilevel tobit and logit regressions, we used the "metobit" and "melogit" mixed effects routines in STATA. To produce the figures, we used the R package ggplot2 v. 3.3.0.

The relative differences in observed and adjusted proportions were calculated with six decimals.

To produce Table 1, we manually categorized journals by specialty. Four authors participated in grouping the journals, with at least two independently coding every journal, and with discrepancies addressed by team consensus.

Competing interests

JPA, MWN and NLS declare no competing interests. RJ has stock options as compensation for her advisory board role in Equity Quotient, a company that evaluates culture in health care companies; she has received personal fees from Amgen and Vizient and grants for unrelated work from the National Institutes of Health, the Doris Duke Foundation, the Greenwall Foundation, the Komen Foundation, and Blue Cross Blue Shield of Michigan for the Michigan Radiation Oncology Quality Consortium. She has a contract to conduct an investigator-initiated study with Genentech. She has served as an expert witness for Sherinian and Hasso and Dressman Benzinger LaVelle. She is an uncompensated founding member of TIME'S UP Healthcare and a member of the Board of Directors of ASCO. REL has no financial disclosures. She is a founder of TIME'S UP Healthcare, a non-profit initiative that advocates for safety and equity in healthcare and an advisor for [FeminEM.org](https://www.feminem.org/), a website that supports the careers of women in medicine.

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Figure 1 Source data 1. Mixed Tobit Model Predicting the overall share of women per article, using journals as random effects and treatment [intervention] as fixed effect.

		Coef.	SE (robust)	95% CI	
Fixed	Intercept	.354	.007	.339	.369
	Intervention (dummy)	-.056	.010	-.075	-.036
Random	Journal (intercept)	.013	.002	.010	.016
Intra-class corr.	Journal	0.159	0.170	0.128	0.195
	Number of disciplines	250			
	Number of respondents	38,710			
	Log Likelihood (fixed effects model)	-8453.0067			
	Log Pseudo-likelihood (full model)	-5884.0835			

Note: The model is computed with robust standard errors.

Figure 1 Source data 2. Mixed logit model with first-author gender as outcome (woman=1) , using journals as random effects and treatment [intervention] as fixed effect.

		Coef.	SE (robust)	95% CI	
Fixed	Intervention (dummy)	-.414	.069	-	-.279
				.548	
Random	Journal (constant)	.270	.030	.22	.336
Intra-class corr.	Journal	.076	.008	.068	.093
	Number of disciplines	250			
	Number of respondents	38,710			
	Log Likelihood (fixed effects model)	-			
	Log likelihood (full model)	25286.986			
		24469.623			

Figure 1 Source data 3

. Mixed logit model with last-author gender as outcome (woman=1) , using journals as random effects and treatment [intervention] as fixed effect.

		Coef.	SE (robust)	95% CI	
Fixed	Intervention (dummy)	-.250	.074	-.394	-.105
Random	Journal (constant)	.381	.043	.306	.475
Intra-class corr.	Journal	.104	.010	.085	.126
	Number of disciplines	250			
	Number of respondents	38,710			
	Log Likelihood (fixed effects model)	-22162.618			
	Log likelihood (full model)	-21278.292			