Impact of the Coronavirus Disease 2019 Pandemic on Authorship Gender in *The Journal of Pediatrics*: Disproportionate Productivity by International Male Researchers

Wadsworth A. Williams, II, MA[1], Alice Li, BA[2], Denise M. Goodman, MD, MS[1,3], and Lainie Friedman Ross, MD, PhD[4,5]

Objective To assess the impact of the coronavirus disease 2019 (COVID-19) pandemic on authorship gender in articles submitted to *The Journal of Pediatrics.*

Study design Using gender-labeling algorithms and human inspection, we inferred the gender of corresponding authors of original articles submitted in January-February and April-May of 2019 and 2020 noting those articles related to the COVID-19 pandemic. We used Pearson χ^2 tests to determine differences in gender proportions during the selected periods in the US and internationally.

Results We analyzed 1521 original articles. Submissions increased 10.9% from January-February 2019 to January-February 2020 and 61.6% from April-May 2019 to April-May 2020. Women accounted for 56.0% of original articles in April-May 2019 but only 49.8% of original articles in April-May 2020. Original articles focused on COVID-19 represented a small percentage of additional articles submitted in January-February 2020 (1/33 or 3.0%) and (53/199 or 26.6%) in April-May 2020 compared with the number of submissions in the same months in 2019. International male corresponding authors submitted a significantly larger proportion of original articles compared with international female corresponding authors in April-May 2020 compared to April-May 2019 (P = .043). There was no difference in corresponding author gender proportion in the US (US in April-May of 2020 vs April-May of 2019; P = .95). There was no significant difference in final dispositions based on corresponding author gender for original articles from 2019 and 2020 (P = .17).

Conclusions Original article submissions to *The Journal* increased in April-May 2020, with the greatest increase by international male corresponding authors. The majority of the submission growth was not related to COVID-19. *(J Pediatr 2021;231:50-54)*.

The coronavirus disease 2019 (COVID-19) pandemic has had far-reaching global implications. As of November 1, 2020, the World Health Organization reports that there are more than 54 million confirmed cases and 1.3 million deaths from COVID-19.[1]

One area that has garnered attention is the disproportionate impact of the pandemic on academic authorship for women. Women submitted fewer articles to preprint servers in the fields of physical sciences, life sciences, and medicine in February-April 2020.[2-4] There was a 7% reduction in women as corresponding authors for manuscripts submitted to *JAMA Surgery* when comparing April-May 2020 with April-May 2019.[5] Early analyses of published articles concerning COVID-19 found a smaller proportion of women than expected.[3,6,7] This observed authorship gap has no definitive causes but is theorized to stem from an unequal burden of domestic and child care responsibilities on women.[2,5,6]

To date, there have been no studies analyzing the effect of the COVID-19 pandemic on authorship gender in the field of pediatrics. Although in general children have mild symptoms and are less likely to require intensive care and are less likely to die,[8,9] the field of pediatrics merits attention to gender equity, as it is the field of medicine with the greatest percentage of female physicians.[10] According to data from the Association of American Medical Colleges, there were 63 902 active pediatricians in the US in 2017, and 61.7% were female.[10] Data from the 2015 American Academy of Pediatrics Pediatrician Life and Career Experience Study show that US female pediatricians were responsible for a greater share of household responsibilities than their male peers and were more likely to report hiring help for cleaning, outdoor work, and childcare.[11] As a result, female US academic pediatricians may be at significant risk of negative publishing and adverse career consequences created by the COVID-19 pandemic. Of note, corresponding data about international pediatricians, regarding both the number of men and women doing pediatric research and their

COVID-19 Coronavirus disease 2019

From the [1]Feinberg School of Medicine, Northwestern University; [2]Pritzker School of Medicine, University of Chicago; [3]Division of Critical Care Medicine, Ann and Robert H. Lurie Children's Hospital of Chicago; [4]MacLean Center for Clinical Medical Ethics; and [5]Department of Pediatrics, University of Chicago, Chicago IL.

D.G serves an associate editor of *The Journal of Pediatrics*. L.R. serves on the Editorial Board of *The Journal of Pediatrics* and also serves on the Editorial Boards of the *Journal of Clinical Ethics*, the *Journal of Empirical Research in Human Research Ethics (JERHRE)*, and *Perspectives in Biology and Medicine*. The other authors declare no conflicts of interest.

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work–life balance, are lacking. We aimed to study the impact of COVID-19 on the research productivity of women and men by comparing the proportion of female and male researchers submitting manuscripts to *The Journal* before and during the pandemic.

Methods

We were given access to Elsevier's database for original articles submitted to *The Journal of Pediatrics* for the months of January-February and April-May for both 2019 and 2020. The year 2019 served as a control to compare with 2020. April-May 2020 were used as the months affected by the pandemic. We distinguished original manuscripts submitted that concerned the COVID-19 pandemic by examining articles that included the key words "COVID-19," "SARS-CoV-2," "coronavirus," or "pandemic" (hereinafter referred to as pandemic original manuscripts).

We evaluated final dispositions of the 2019 and 2020 original articles. Our final update of dispositions was October 30, 2020. In addition, we compared this 2019 and 2020 period with data from *The Journal* that we published in 2015 and 2016 to establish a longitudinal trend.[12]

Corresponding Authors

The Journal retains the names of first authors and corresponding authors of all submitted articles but does not retain the names of senior authors. The only other identifying information retained about rejected articles is the country-of-origin of the corresponding authors. Therefore, we chose to analyze the gender and country-of-origin (US vs international) of corresponding authors to account for potential global differences from the pandemic.

Gender Inference

We rigorously inferred the gender of corresponding authors for all analyzed manuscripts through the use of gender inference algorithms and human identification. As outlined in the methods of our previous research,[12] the initial screen began with a gender-inference program created by the researchers with MATLAB (R2020a, MathWorks Inc). Our internal inference program was set with high specificity and has an error rate of <1%. For all names that were not inferred by the program, authors searched the internet for academic profiles and online accounts (such as Research Gate, LinkedIn, Doximity, and institutional websites) to find pronouns or images identifying the gender of the author. One challenge in gender inference research is accurately labeling the gender of Asian names because of a lack of reliable census information, regional and ethnic variations of gender-association with specific names, and a difference in how self-identified "first" and "last" names are reported to *The Journal*. We used an outside algorithm to identify gender for those names that were not labeled after human inspection. Following research by Santamaría and Mihaljević, comparing commercially available databases for gender inference research, we used Gender API to minimize false-positive identification, as it has the largest sample of names and the lowest misidentification rate of studied databases.[13] We included a name as a positive identification if it was labeled with 100% accuracy according to the Gender API, or if it had a >70% rated accuracy from a sample of more than 50 names. We used this previously validated Gender API percentage accuracy threshold of 70%,[14,15] and additionally imposed a sample size requirement to help minimize type I errors. All names were treated the same, regardless of author's country-of-origin, to avoid biasing the gender inference.

Statistical Analyses

We analyzed gender proportion for submissions and dispositions of articles from 2019 and 2020 using the Pearson χ^2 test. For the comparison of dispositions for pandemic-focused original articles, we used a Fisher exact test. Significance was set at $P = .05$. The University of Chicago institutional review board exempted this research and waived the need for informed consent.

Results

Original Articles Submitted Between 2019 and 2020

There were 1521 original articles submitted to *The Journal* during the studied time periods of January-February and April-May of 2019 and 2020. Only 39 (2.6%) corresponding author genders could not be inferred and were excluded from gender analysis. Of the 1482 original articles studied in 2019 and 2020, the first author was the corresponding author for 876 (59.1%) of submitted articles. The majority of articles (925/1482 or 62.4%) were submitted by international corresponding authors (**Table I**). In 2019 and January-February of 2020, women corresponding authors represented an average of 55.0% of all original articles submitted (53.0% international corresponding authors, 56.0% US corresponding authors). However, in April-May of 2020, during the COVID-19 pandemic, women were the corresponding author of only 49.8% of all submitted original articles (46.9% international corresponding authors, 55.9% US corresponding authors).

Original articles submitted in January-February 2019 compared with January-February 2020 showed a 10.2% increase. In contrast, submissions in April-May 2020 increased by 61.6% compared with April-May 2019 (international corresponding authors growth +80.5%, US corresponding authors growth +32.8%). Female corresponding authors during April-May 2020 demonstrated a year-over-year growth of 43.6% (international female corresponding authors 51.4%, US female corresponding authors 31.9%) compared with 84.5% for male corresponding authors (international male corresponding authors 117.4%, US male corresponding authors 33.9%).

There was no significant difference in the proportion of corresponding author gender for all original articles submitted between January-February of 2019 compared with

Table I. Comparing gender proportion of corresponding authors for original articles submitted—select months of 2019 vs 2020

Corresponding author origin—time periods	Total corresponding authors, no.	Female corresponding authors, no. (%)	Male corresponding authors, no. (%)	*P* value
All—January-February 2019	302	161 (53.3)	141 (46.7)	.53
All—January-February 2020	335	187 (55.8)	148 (44.2)	
International—January-February 2019	175	91 (52.0)	84 (48.0)	.74
International—January-February 2020	203	109 (53.7)	94 (46.3)	
US—January-February 2019	127	70 (55.1)	57 (44.9)	.52
US—January-February 2020	132	78 (59.1)	54 (40.9)	
All—April-May 2019	323	181 (56.0)	142 (44.0)	.078
All—April-May 2020	522	260 (49.8)	262 (50.2)	
International—April-May 2019	195	109 (55.9)	86 (44.1)	**.043**
International—April-May 2020	352	165 (46.9)	187 (53.1)	
US—April-May 2019	128	72 (56.3)	56 (43.8)	.95
US—April-May 2020	170	95 (55.9)	75 (44.1)	

Value in bold are statistically significance at *P* value.

January-February of 2020 ($P = .53$, Table I). There was also no significant difference in the gender proportion of corresponding authors when comparing all original article submissions between April-May of 2019 vs April-May 2020 ($P = .078$). However, there was a significantly lower proportion of original article submissions by international female corresponding authors in April-May 2020 compared with April-May 2019 ($P = .043$).

Final dispositions were assigned for 99.3% (1472/1482) of analyzed original articles submitted in the select months of 2019 and 2020. As shown in Table II, there was no significant difference in final manuscript dispositions for original articles submitted during these months based on corresponding author gender. All female corresponding authors had an acceptance rate of 16.3% compared with male corresponding authors (13.6%, $P = .17$). International female and international male corresponding authors were accepted at a lower rate (7.7% and 8.0%, respectively) compared with the acceptance rate of US female and US male corresponding authors (29.2%, $P < .00001$ and 24.0%, $P < .00001$ respectively).

COVID-19 Pandemic–Related Research: January-February 2020 and April-May 2020

We analyzed 54 original manuscripts concerning the COVID-19 pandemic that were submitted to *The Journal* in January-February and April-May 2020 (Table III). The first pandemic manuscript submitted was from China on February 13, 2020, which was the only pandemic original article in January-February. The gender for all 54 of these manuscripts was inferred. International authors submitted 87.0% of all pandemic original manuscripts. Female corresponding authors authored 48.1% of all pandemic-focused original articles. Manuscripts were submitted primarily by China in February but by April and May, submissions began to increase around the globe, with Italy leading all pandemic original manuscripts submissions in April and the US in May.

Table II. Final dispositions of all original articles—January-February and April-May of 2019 and 2020

Corresponding author origins—dispositions	Female corresponding authors		Male corresponding authors		*P* value
	No.	Gender rate %	No.	Gender rate %	
All—Accept	129	16.3	94	13.6	.13
All—Reject	653	82.8	594	85.7	
International—Accept	37	7.7	36	8.0	.93
International—Reject	435	91.8	414	91.8	
US—Accept	92	29.2	58	24.0	.17
US—Reject	218	69.2	180	74.4	

Discussion

There was a large increase in the number of original article submissions to *The Journal* in April-May 2020 compared with April-May 2019 as the COVID-19 pandemic spread across the globe. However, original manuscripts related to the pandemic only accounted for approximately one-quarter of the increase in articles submitted. Although submissions increased globally, international men had the greatest increase in submissions. Most submissions in April-May 2020 would have involved research conducted before the emergence of COVID-19, and researchers may have availed themselves of the shelter-in-place rules to complete manuscripts already in progress. More analysis is necessary to understand why international female researchers and male and female US researchers were comparatively less productive. What impact COVID-19 is having on initiating and completing new projects (both COVID-19 and non–COVID-19–related) in both the short and long term still remains to be seen. Given the long timeline of research projects (from idea

Table III. Combined pandemic-focused original articles (January-February and April-May 2020)

Origins of corresponding authors	No. submitted/no. accepted		
	All	Female corresponding author	Male corresponding author
All	54/24	26/1	28/2
International	48/1	22/0	26/1
US	6/2	4/1	2/1

generation and procuring funding to conducting the research and reporting on the findings), the full impact on researcher productivity and whether there is a gender difference will not be known for months to years.[16,17]

Our data show that international male corresponding authors had the largest productivity gain, as measured in the number of submissions to *The Journal* early in the pandemic. The change in gender proportion for international corresponding authors of original articles from a previous female majority (average of 53.0% during nonpandemic months of 2019 and 2020) to a female minority (46.9%) in April-May 2020, is noteworthy and may suggest a comparative disproportionate harm to international female researchers. US male and female researchers had a smaller increase in publication submissions to *The Journal* at this point in the pandemic, suggesting a comparative productivity disadvantage for US researchers compared with their international counterparts. Research is needed to determine whether this comparative productivity disadvantage is true in other medical specialty and subspecialty fields and whether it persists over time.

The gendered impact of the pandemic on international authors is not fully appreciated in the medical literature to date, which focuses mainly on authorship gender of US researchers.[3,6,7] For example, Andersen et al only analyzed authors affiliated with US institutions,[6] Frederickson used only US Social Security Administration data to infer gender,[4] and Vincent-Lamarre et al and Kibbe did not differentiate international from US authors in their analyses.[3,5] Many top-tier academic journals, including *The Journal*, receive a large volume of submissions from international authors.[18-20] As researchers continue to uncover the far-reaching implications of the pandemic on gender, the long-term effects on gender in different global regions should be explored.

In contrast with their international colleagues, male and female US corresponding authors had a similar comparatively smaller increase in submissions. A variety of factors may help explain why we are not seeing the adverse impact on US women pediatric researchers that has been described for female researchers in other areas of science and medicine.[2-5] First, the field of pediatrics has had a lesser clinical burden of COVID-19–related illness, although other societal disruptions such as school closures would still be expected to affect pediatricians. Second, male and female US pediatric researchers may be taking on similar family childcare responsibilities such that their productivity is being equally affected (growth by US male corresponding authors [+34%] and US female corresponding authors [+32%] are lower than the increased productivity of international male corresponding authors [+117%] and female corresponding authors [+51%]). Alternatively, the studied period of April-May 2020 may be too early to see the full impact on gender. Although not seen in April-May 2020, the potential for a differential impact of the pandemic on US female researchers requires vigilance because comparatively lower productivity may still occur.[16] Increased familial childcare burden persists due to the failure of many K-12 schools to resume school fully in-person in August-September 2020,[21] and the increasing cases occurring in October-November 2020 suggest that full resumption of in-person schooling for many children may not occur this academic year.[22,23]

Our study has several limitations. First, this manuscript is limited to 1 pediatric journal. We only used data from *The Journal* because it allowed us access to its internal database, which includes all submitted manuscripts, both those accepted and rejected. Thus, despite the limitation, we were able to analyze not only those manuscripts accepted but also those rejected. We have previously shown that manuscript acceptance at *The Journal* is gender-neutral,[12] and we were able to show that this was still the case during the pandemic. Second, we only analyzed the gender of corresponding authors, not first or last authors, because *The Journal*'s database does not retain information for the last author nor the country-of-origin of the first author for those articles that are rejected. It is possible that there is a differential gender effect of the pandemic on authorship gender of first authors (more junior authors who may be younger and have younger children) than last authors (who may be older and have older children). However, 59.1% of corresponding authors were first authors. Third, we recognize that gender is a societal construct and inferring gender from an image may not represent the gender of the individual. In addition, name inference from database and image identification may marginalize groups that do not conform to the concept of binary genders. Fourth, we only studied a few discrete segments of time, so we were not able to model any trends over time. Given that the pandemic shows no signs of ending soon, further research needs to be done.

COVID-19 has created massive changes to society and medicine. Equity in career opportunities and advancement requires that the academic community is vigilant about the potential differential impact on the productivity of female and male researchers in both the short-term and long-term in both the US and around the world.

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Reprint requests: Lainie Friedman Ross, MD, PhD, Department of Pediatrics, University of Chicago, 5841 S Maryland Ave, MC 6082, Chicago, IL 60615. E-mail: Lross@uchicago.edu

Data Statement

Data sharing statement available at www.jpeds.com.

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