13-Year Analysis of Gender Disparity in Peer-reviewed Burn Literature

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Women are less likely to be senior authors, invited to write in scientific journals, and to be cited in high impact journals. The aim of this study was to investigate trends in authorship and gender differences in peer-reviewed burn literature over 13 years. We performed a retrospective analysis of original research articles published from January 2009 to September 2021 in three burn journals. A gender determination application was used to categorize the gender of the first and senior author. Of the 3908 articles analyzed, 42.5% had a woman first author and 27.6% had a woman senior author. We identified 2029 unique senior authors, 29.0% of whom were women. Woman senior authorship was associated with increased odds of woman first authorship [OR = 2.31 (95% CI: 2.00, 2.67); *P* < .001]. The percentage of papers with a woman senior author increased from 17.8% in 2009 to 35.7% in 2021. If this 1.0% (95% CI: 0.50–1.51%) linear trend increase per year in woman senior authorship continues, we will expect to see equal proportions of woman and man senior authors in the included journals starting in 2037. The field of burn care is far from reaching gender parity with respect to authorship of peer-reviewed publications. Supporting and encouraging gender-concordant and discordant first:last authorship dyads in mentorship as well as redistributing obligations that may detract from authorship opportunities are potential ways to improve parity in authorship and academia.

Despite increased efforts to advance the representation of women in medicine, women remain underrepresented in the surgical field. In 2019, 17.24% of practicing plastic surgeons were women and 22.03% of practicing general surgeons were women.[1] This under-representation is also reflected in research authorship, where studies have shown that women are less likely to be senior authors,[2–4] invited to write in scientific journals,[2] and to be cited in high impact journals.[5] Specifically, in plastic and reconstructive surgery research articles, women make up less than 20% of first and senior authors.[3,6] This gender disparity in research may impact career trajectory as research is an important contributor to recognition, professional advancement, and leadership roles. A survey of surgical chairpersons found that 61.5% viewed scholarly productivity as very important to becoming a successful surgical chair.[7] However, women hold 33 out of 331 surgical chair department positions in the United States[8] and are less likely to achieve the rank of professor.[8,9] This disparity is also seen in burn surgery leadership, where a cross sectional study in 2020 found that women represented 2.9% of the American Burn Association and International Society for Burn Injuries past presidents, 10.5% of burn journals' editorial board members, and 17% of burn unit directors.[10]

Currently, there is a paucity of studies evaluating gender representation in peer-reviewed burn publications. Analysis on gender authorship may assist with understanding the barriers and bias women face in medicine. Therefore, the aim of this study was to investigate trends in authorship and gender differences in peer-reviewed burn literature over 13 years.

METHODS

Using methodology previously described by Chary et al,[4] we performed a retrospective bibliometric analysis of original research articles published from January 2009 to September 2021 in three burn journals: *Burns, Journal of Burn Care and Research,* and *Burns and Trauma*. No IRB approval was required, as authorship data is publicly available, and no patients were involved in this study.

For a comprehensive list of publications by each journal, we referred to the Table of Contents for each Issue between January 2009 to September 2021 and manually screened articles for inclusion. The type of publication was predefined by the journal. We selected articles based on our predetermined inclusion criteria: 1) original research studies including clinical trials, observational studies, systematic reviews and meta-analyses, and experimental studies on human subjects

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and samples; 2) studies published within the specified time period; and 3) studies published within one of the pre-specified journals. We excluded non-original research studies including case reports, case series, letters to the editor, commentaries, guidelines, narrative reviews, and consensus guidelines; single author publications; and publications with first or senior authors whose full name or gender was unidentifiable by manual determination (Figure 1).

We manually collected full author names of the first author, defined as the author whose name was listed first in the publication, and senior author, defined as the author listed last. A gender determination application ("Gender API") was used to categorize the gender of the first and senior author.[11] If gender was not provided by Gender API, or if output result was delivered with < 75% certainty, gender was manually determined using an Internet search. Authorship ratios (first author:senior author) for woman:woman, woman:man, man:woman, and man:man were calculated.

For each unique senior author identified, we calculated a Woman First Author Index (WFA-index) = #Woman first authors in publications by an individual senior author/ Total # of publications by that senior author.[4] This ratio represents the proportion of woman first authors in the publication record for an individual senior author amongst the three journals analyzed. The higher the WFA-index, the greater the proportion of woman first authors represented in a senior author's publication record.

Statistical Analysis

Statistical analyses were conducted using R statistical software version 4.0.2 and RStudio version 2022.07.1. Categorical variables were described using frequency distribution and compared using Chi-squared analysis. Continuous variables, namely WFA-indices, were found to follow bimodal distributions, with the majority of the values being 0 or 100. Thus, both mean (standard deviation) and median (lower quartile, upper quartile) statistics were reported to better describe the distributions of WFA-index values, and the Mann–Whitney *U* test was used for comparison. A logistic regression model was used to assess the association between woman senior authorship and woman first authorship. Linear regression models were used to model the time trend of authorship gender composition.

RESULTS

A total of 4327 original research articles were included in our analysis. Of those, Gender API was able to provide the gender of the first and senior author of 3260 publications with >75% confidence. Of the remaining 1067 articles, we were able to determine the gender of the first and senior authors of 648 articles by a manual Internet search, and 448 articles failed manual gender determination and were thus excluded from our analysis. This led to a final cohort of 3908 original research articles (Figure 1).

Of the 3908 articles analyzed, 42.5% had a woman first author and 27.6% had a woman senior author. We identified 2029 unique senior authors, 29.0% of whom were women. The proportion of papers with a woman first author and a woman senior author (W:W) rose by 0.78% (percentage point change) (95% CI: 0.31–1.25%) per year from 2009 to 2021. In 2021, this proportion was 23.2% compared to 6.5% in

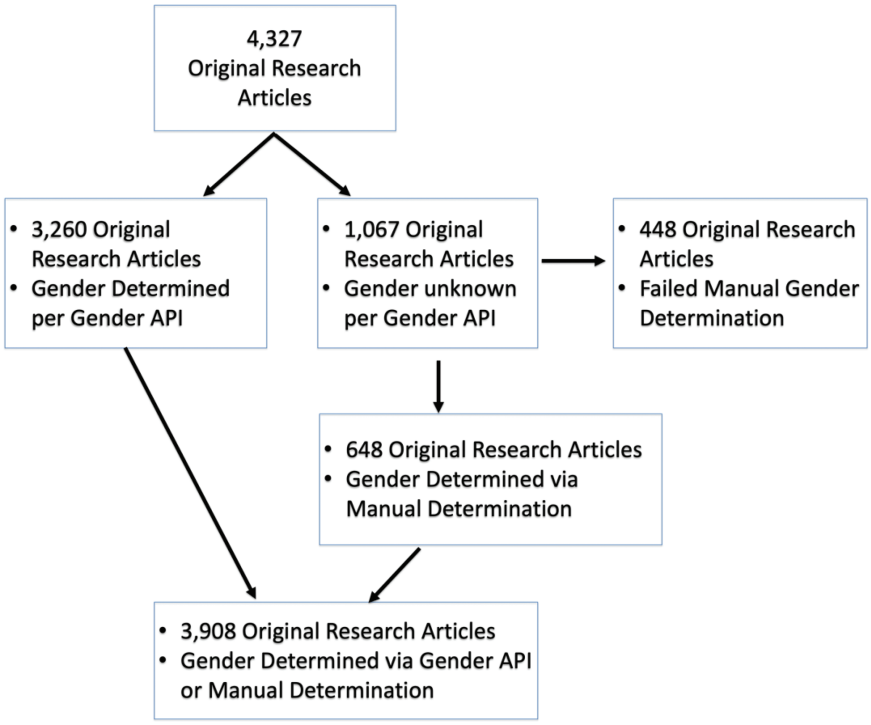

Figure 1. Flowchart of Authorship Gender Determination process applied to all identified original articles.

2009 ($P < .001$). The proportion of papers with a woman first author and a man senior author (W:M) remained nearly the same in 2021 compared to 2009 (23.5% vs. 26.5%, $P = .50$), as did the proportion of man first author to woman senior author (M:W) (12.5% vs. 11.3%, $P = .78$) (Figure 2). The proportion of man first author to man senior author (M:M) decreased from 58.7% in 2009 to 37.9% in 2021 ($P < .001$). During the start of the COVID-19 pandemic (2020–2021), the proportion of papers by man first authors (M:M and M:W) decreased and the proportion of papers by woman first authors (W:M and W:W) increased (Figure 3).

The mean (*SD*) and median (IQR) WFA-index for all 2029 individual authors were 38.9 (45.5) and 0 (0, 100), respectively. Stratifying by last author gender, the mean (*SD*) and median (IQR) WFA-index for man senior authors (N = 1440) were 32.5 (43.3) and 0 (0, 100) and for woman senior authors (N = 589) were 54.5 (47.0) and 70 (0, 100) (Mann–Whitney *U* test $P < .001$). Woman senior authorship was associated with increased odds of woman first authorship [OR = 2.31 (95% CI: 2.00, 2.67); $P < .001$]. In our sample, when the senior author was a woman, 57% of their first authors were women compared to when a man was a senior author, 36% of their first authors were women.

The percentage of papers with a woman senior author increased from 17.8% in 2009 to 35.7% in 2021. If this 1.0% (95% CI: 0.50–1.51%) linear trend increase per year in woman senior authorship continues through the future, we will expect to see equal proportions of woman and man senior authors in the included journals starting in 2037.

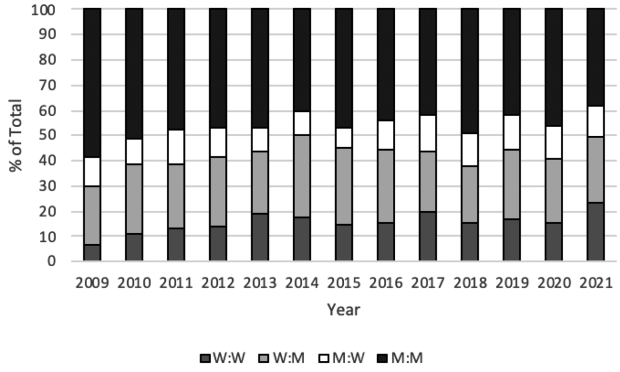

Figure 2. Proportion of publications over time broken down by first:senior author pair gender.

DISCUSSION

In this study of women's representation in first and senior authorship positions, our results demonstrate that the field of burn care is far from reaching gender parity with respect to authorship of peer-reviewed publications. Of all the articles analyzed, less than half had a woman first author and less than one-third had a woman senior author. Among total unique senior authors, 29.0% were women. Though limited data exists on the number of women in the burn care workforce, existing data suggests that over half of the members of the American Burn Association identify as women.[12] Additional data demonstrate that slightly over half (50.5%) of medical students,[13] 42% of integrated plastic surgery residents, and 34.7% of general surgery residents are women. In 2019, only 22% of active general surgeons and 17.2% of active plastic surgeons were women.[14] Thus, our data suggest that decreasing women's representation in authorship from first authors (often medical students and residents) to senior authors (often faculty and practicing physicians) is both a pipeline and retention issue. Women are entering the surgical field at a lower rate than men[15] and studies have shown that women surgeons may have more responsibilities and limitations on their time outside of work,[16,17] especially during the COVID-19 pandemic.[18] Women also tend to take on more communal work responsibilities such as being educators and performing committee work.[19] These non-scholastic activities within and outside of the workplace may manifest in less time that can be devoted to research and authorship. Interestingly, our data demonstrated a modest increase in woman:woman and woman:man authorship between 2020 and 2021, a finding that disagrees with data published elsewhere across Science, Technology, Engineering, and Mathematics fields indicating women's authorship was negatively impacted by the COVID-19 pandemic.[20–22] We found that the number of man:man and man:woman first:last author publications decreased during this same period. This may be due to a longer than expected lag time between submission, acceptance, revision, and publication of manuscripts during the COVID-19 pandemic. As average time to publication from acceptance may vary, we

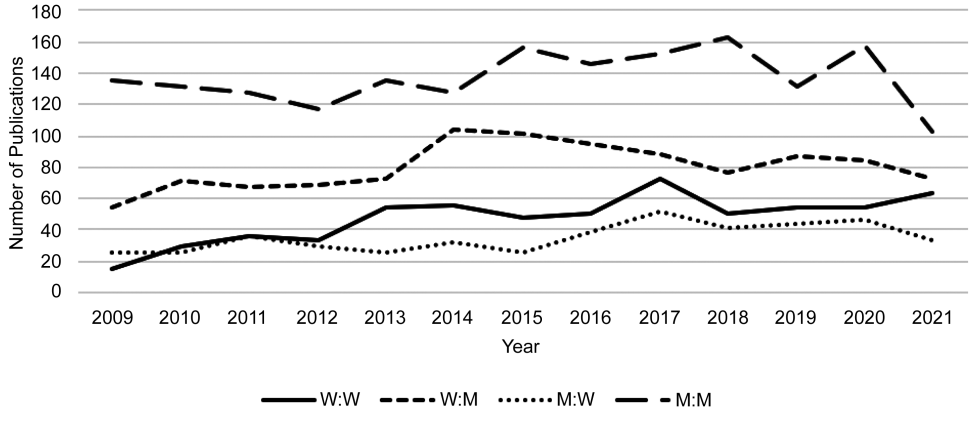

Figure 3. Number of publications over time by first:senior author pair gender.

hypothesize that the timeline of our data collection may not have been sufficient to demonstrate the impact of the pandemic, and that one more year of complete data may be necessary to see the real effects of the pandemic on publications of manuscripts by gender.

Our data indicated that the proportion of papers with a woman first and woman senior author rose over the study period, from 0.07 in 2009 to 0.23 in 2021. This may be due in part to the increasing number of woman surgeon trainees completing training and entering the burn workforce. Additionally, as more woman mentors become available, woman trainees may more actively seek out their mentorship as has been demonstrated in other published studies,[23,24] resulting in more coauthored publications. Indeed, our data seem to support this given that woman senior authorship had an increased odds of woman first authorship by over two-fold while the proportion of papers with a man senior author and a woman first author remained the same over the course of the study. While this highlights that woman senior authors may be more likely to take on woman first authors as mentees, and that gender-concordant woman first and senior authorship is rising, it is important to continue to encourage gender-discordant mentorship as data suggests that mixed-gender authorship is predictive of citations.[25,26]

In the context of the "#MeToo" movement,[27,28] "BlackLivesMatter",[29] and the COVID-19 pandemic, all of which urge for a critical lens to be applied to gender and racial equity issues across all aspects of society, it is important for the field of burn care and surgery to recognize the undue burden that woman and researchers may face in addition to their workforce duties. Some documented ways of promoting gender equity for female physicians in academic medicine include identifying mentors, both gender-concordant and gender-discordant, using social media to enhance opportunities for open dialogue and increase the visibility of scientific contributions,[26] expanding access to formal leadership programming, and increasing journal editorial board representation.[30] Recognizing and quantifying the disparity is the first step. Future efforts must focus on developing interventions on all levels of the professional continuum to support and promote women's professional development in the field of burn care and surgery, including their success in authorship of peer-reviewed burn literature.

Limitations

Our study has limitations. First, we calculated authorship ratios and WFA-indices for senior author publications from three burn journals and our findings may not translate across the remaining burn, general, and plastic surgery literature. The Gender API algorithm uses government datasets and social media data to predict gender, which may be imprecise. We used its prediction of certainty (with a cutoff of 75% certainty) to limit imprecise outputs. Despite using a manual search strategy to determine gender of first and last authors unidentified by Gender API, we were unable to determine gender of either first or last author of 10.4% of publications in our dataset, which may introduce bias among authors with unisex names or lack of a prominent online presence. Additionally, there is a lack of available data regarding gender breakdown of the burn workforce, both within the physician workforce and multidisciplinary burn care teams, making it difficult to compare our findings to baseline gender data. These data are vital to understanding how representative our findings are compared to the gender breakdown of burn surgery trainees and physicians, elucidating the true magnitude of gender disparity in authorship. Additionally, using a gender-based application to determine gender of authors constrained our analysis to a binary format. Furthermore, manual determination of gender required assumptions based on external physical presentation. Both these methods of gender identification excluded individuals who do not identify within the gender binary structure. As we strive to foster an environment of diversity and inclusion within medical and academic spaces, it will be important to develop mechanisms to include non-binary individuals in efforts to quantify and address disparities. We must also remember that gender is just one variable that may predispose the marginalization of certain subgroups within the field of academic burn surgery. These biases are intersectional and may also be influenced by race, sexual orientation, socioeconomic status, geographical region, and other factors.

CONCLUSION

While women's representation in first and senior authorship positions is increasing, our results demonstrate that the field of burn care is an estimated 15 years from reaching gender parity with respect to authorship of peer-reviewed publications. Supporting and encouraging gender-concordant and discordant first:last authorship dyads in mentorship as well as redistributing obligations that may detract from authorship opportunities are potential ways to improve parity in authorship and academia.

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