



Female is Not First: the Gender Gap in Publishing Means More Needs to be Done

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This month's *Pharmaceutical Research* issue is a collaboration with AAPS' Women in Pharmaceutical Sciences Community intentionally focusing on women as first authors to celebrate and recognize the contributions women make in several research areas. Gender bias in science is a common theme, the most notable historic example being Watson and Crick's use of Rosalind Franklin's X-ray crystallography work to support their hypothesis on the structure of DNA without providing her the appropriate credit. To this day, gender disparity across scientific fields remains prevalent and spans countries and disciplines [1–3].

Scientific publication gaps in female vs. male-authored articles is well documented. A historical analysis looking at publication history of gender identified authors found that while women have increased their representation in science, gender differences remain, most notably in productivity and impact. The study found that throughout their career, on average, male scientists publish 13.2 papers while female scientists publish 9.6, a 27% gap in productivity. The study also found that men receive 30% more citations than women [4]. In 2017, *Lancet* called for evaluations of gender bias and one study found that across three medical journals (*New England Journal of Medicine*, *Journal of the American Medical Association* and *Lancet*), women first author publication rates were lower with no improvement over time [5]. Another study examined data from more than 85,000 *Public Library of Science (PLOS)* articles, examining the task associated with an author. Results determined that women are more often the lead on performing the experimentation while the male author is associated with other tasks, including contribution of resources. The study concluded that men's authorship is related to resourcing, women's with performance of the science [6]. Collaboration bias was identified as a factor

impacting women in scientific publishing. Male scientists tended towards collaborating solely with other male scientists, which correlated with publishing in higher impact journals across scientific fields compared to female only collaborations or solo research publications [7]. Unconscious bias in article review may contribute to a lack of female scientists authoring and submitting to journals, suggesting the need for double-blind peer review system. In one study, male editors selected fewer female reviewers while female editors were consistent in the proportion of female reviewers selected (<25% vs. 30–35%) [8]. Editor and peer review bias may be perceived by submitting authors, and affects when and where articles are submitted, possibly due to a lack of women involved in peer review or editorial appointees [9].

Beyond the role bias plays, funding in the scientific field also effects women disproportionately. The number of NIH Grants awarded to women from 1998 to 2022 ranges from 23% in 1998 to only 38% in 2022 [10]. The lack of funding likely contributes to the lack of publications from women first authors, as they have fewer resources to conduct their research. Age also seems to play a role in the gender differences seen in publications and impact. The AAPS Salary survey noted that males have more experience than females (22.9 years vs. 14.3 years) and females make up the majority of the AAPS student members and members under age 35 [11]. Trends in publication bias may be explained by simple numbers: fewer women in senior roles correlates with fewer authorships and citations [1]. This suggests a need to support women throughout their career to ensure longevity and reduce the current representation gaps observed.

Men outnumber women in the scientific field 2:1 even though female participation continues to increase [4]. Publishing gaps, salary and funding gaps, and unconscious biases all point to several factors disproportionately affecting women and their careers including family responsibilities, career absence, level of responsibility, and stereotypes. This, in turn, results in impacts to her career that result in gender inequality and decreased lifetime earnings. In biopharma

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companies, women make up almost half the workforce, at executive level that number significantly drops to less than 10% [12]. Interestingly, data supports that diversity at the CEO level results in better performance, with executive teams made up of more than 30% women were almost 50% more likely to outperform teams with less than 10% women [13]. The data reflects the impact women have on the scientific field, they just need to opportunities and support to do so. Schools and companies must focus on increasing diversity in leadership. Funding, editorial review boards and reviewers must not only be diverse in their makeup but improve their processes to ensure unbiased review, such as blinding themselves to the names or gender of submissions. Increasing allyship, recognizing bias, and making a concerted effort to promote and support women across all levels will move us closer to closing the gender gap.

In this Special Issue, topics range from drug delivery to formulation to job satisfaction. Mazen Abdel-Rasheed explores the cytotoxic effect of zinc oxide nanoparticles as an alternative for the treatment of ovarian cancer. Asmita Khanolkar examines a novel approach to drug delivery through an autoinjector simulator to reduce time to clinic. An *in vivo* study by Dr. Hyunah Cho looks at a novel drug delivery system for melanoma treatment through a therapeutic-containing topical nanogel. Anna Krupa provides a thorough review of celecoxib's treatment potentials and formulation challenges. Dr. Yue Gui presents a perspective on solid form screening. Dr. Yeqing Tao examines particle formation as a result of spray-drying and the effects on protein conformation. Wenzhan Yang compares the formulations of an MCl-1 inhibitor and its impact on clinical development. Dr. Lilia Macias-Moriarity focuses on imposter syndrome and job satisfaction in female pharmacy faculty through the Imposter Phenomenon Research Collaborative and finds female faculty to be grittier than their male counterparts. By making a concerted effort to highlight female first authors, *Pharmaceutical Research* takes a step toward reducing the gender disparities in scientific publishing.

AAPS Women in Pharmaceutical Sciences (WIPS) is an inclusive member community that provides women in the pharmaceutical industry and academia with a forum to connect and engage while promoting professional development,

inspiration, and empowerment reflective of our diversity, scientific expertise and leadership.

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