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Commentary

The gender citation gap

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Citing prior work is an important step of scientific progress. However, when bias enters the process, consciously or unconsciously, it can lead to significant consequences. In this commentary, I explore the role of gender in citation bias and highlight its potential impact on equity and diversity in the scientific community.

We scientists obsess about numbers. They are the alphabet through which we communicate the truths we uncover about the reality we experience. Among these numbers, one has achieved iconic status: the h-index. In 2005,[1] J.E. Hirsch proposed the h-index as "the number of papers with citation number $\geq$h," a metric to characterize a researcher's scientific output. Today, it serves as a shorthand for scientific impact. A high h-index is more than just a number; it's a symbol of prestige, a stamp in your scientific passport that can ease your journey through grants, accolades, and, for some, the prestigious awards.

When it comes to referencing previous works in a given area, the scientific community often agrees on which research results were pivotal to that area, and which were of a more incremental nature, but this assessment is to an extent arbitrary, and citation behavior is not clear-cut. This begs the question: do certain works get cited more than similar others? And if so, what are the reasons behind any such preference? This leads us to the concept of citation bias: the idea that citations are influenced not just by scientific relevance but also by less objective factors, sometimes to the detriment of underrepresented groups. Here, we focus on the gender factor.

The question of whether the gender of authors, in particular of the corresponding author, influences citation practices and their consequences has been raised repeatedly.[2–6] Giving an answer to this question can be as hard as formulating the question, as there are several angles to consider on this issue, for example: the likelihood for an author to publish impactful work based on their gender; the perception of the quality of someone's work based on their gender; the likelihood that the community is aware of results based on the author's gender; the citation behavior based on the gender of the person referencing someone else's work.

The role of gender

A first interesting fact when comparing the number of citations by gender is that women are on average cited less than men.[2,3] This needs to be looked at in the context of other factors. One such factor is that senior positions are (still) more likely to be occupied by men than by women,[7] making citations more likely for male authors just on account of their seniority. Another factor has been termed the "1995" effect,[4] and promotes seminal works produced by men when times were more hostile for women in science, a trend exacerbated by Google's popularity-based ranking. Finally, there is a consensus that the dropout of women from science and general scientific productivity (at critical times of their career) is a strong reason why women are less cited than men. Ironically, a study reveals that women's dropout from academia is linked to the low recognition of their work.[8] Overall, these circular arguments point toward an imperfect academic system that fails to quantify merit objectively.

Even more interesting cases are those where it is possible to isolate the role of gender in citation practices. Sophisticated studies in fields like neuroscience[5] and physics[6] have used predictive models to estimate the expected citation patterns of papers, and researchers found a significant difference: papers that were first- (or last)-authored by male scientists were cited more often than the model predicted, while those by female scientists were cited less. This discrepancy highlighted a clear bias, even when the relevance of the work was controlled for.

One might wonder how such bias persists when author identities are often obscured by acronyms or initials. But even this veil of anonymity fails to prevent inequality, especially in male-dominated fields such as physics, where women researchers are greatly outnumbered. At conferences, conversations or discussions often form more easily among peers of the same gender,[10] and interactions with the most influential figures—often men—tend to be prioritized. As a result, male participants may find it easier to approach key figures. And this then becomes a source of citation bias, since networking plays a crucial role in the spread of knowledge and eases the way to find the next collaboration that can lead to more papers to be cited.[11]

Meanwhile, women on average cite more women than men.[6] One can speculate whether this is a form of camaraderie, but it is possible that there is a conscious effort by women to express discomfort by supporting their women peers. This is accompanied by another gender-dependent tendency: women are less likely to self-cite.[3]

A call to action

The prevailing notion that equality can be achieved simply by equalizing numbers—ensuring proportional representation—ignores deeper issues at play. True equity requires addressing the systemic biases embedded in the practices of the research community, including how we cite and value scientific contributions. It's about understanding the extensive

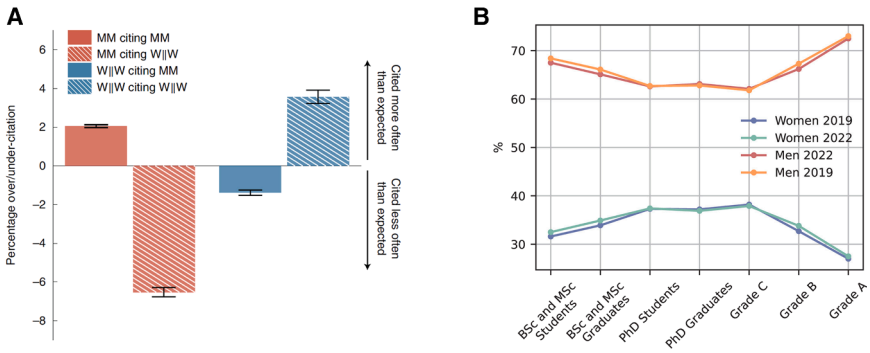

Figure 1. Gender disparities in citation behavior and academic career progression

(A) Over/under-citation of papers first- and last-authored by men-men (MM) and women-women (W||W) and published between 2009 and 2020, calculated separately for MM- and W||W-citing teams. Each team category exhibits citation preference toward their own author gender category. Figure extracted from Teich et al.[6]

(B) Proportion (%) of women and men in a typical academic career in science and engineering, including students and academic staff, in Europe in 2019 and 2022. Data extracted from the "She Figures" report of 2024.[9]

consequences of being a minority in an unbalanced community. If we collectively fail to do this, we run the risk of transforming the agnostic value of the h-index into a form of oligarchy.

As pointed out by the European Commission[9]: "Women remain underrepresented in grade A positions (equivalent to full professorship) across all fields, holding only 30% of these positions. […] In Science and Engineering, the gap is even wider, with women holding just 20% of grade A positions" (Figure 1B). Reaching the highest career levels seems to be still at risk for women.

The "publish or perish" culture is pushing up the number of papers published in physical and technical sciences by a factor of two every 12.9 years,[12] presumably making it more difficult to impartially find papers that are relevant to one's work. With the proliferation of AI and the emerging evidence that it may also be biased,[13] we can only expect an intensification of citation biases.

Citation bias is not just an academic curiosity: it shapes careers, influences funding decisions, and perpetuates inequality. What we need is for scientists, and the next generation in particular, to be conscious of their choices when referencing previous results, and to strive for fairness in recognizing contributions. Some initiatives already advocate for the inclusion of diversity statements[14] in their publications or positive action from the editorial process.[15]

With the advent of social media, professional networks have a huge opportunity to highlight and bring up front the junior scientists. Initiatives like "Research Spotlight" by Quantum Women (https://www.quantum-women.com) propose paths for women's visibility and recognition. Following the mantra of supporting women to achieve their full career potential through the pillars Elevate, Inspire, and Empower, this initiative recognizes and echoes the contributions of women in the field of quantum technologies by promoting their first-authored manuscripts on LinkedIn.

Addressing citation biases and finding their origin is a step toward a more equitable academic community, where the truths we uncover are judged by their relevance and not by the identities of those who uncover them.

DECLARATION OF INTERESTS

The author is co-founder and Board Chair of Quantum Women.

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