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***NOTE:** This commentary was publicly shared as a pre-print on November 24 2020 in response to an [article](#) originally published by Nature Communications on November 17 2020. Following an Editorial investigation, the original article on was [retracted](#) on December 21 2020 (see Editorial commentary [here](#)).*

Flawed data and unjustified conclusions cannot elevate the status of women in science:

Response to “The association between early career informal mentorship in academic collaborations and junior author performance”

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Flawed Data and Unjustified Conclusions Cannot Elevate the Status of Women in Science:

Response to “The association between early career informal mentorship in academic collaborations and junior author performance”

Scientists can and should critically examine the dynamics of, and biases within, their own fields. However, AlShebli and colleagues’ (2020)¹ publication neither advances scientific knowledge nor makes empirically justified recommendations in their recent analysis of the citation rates of 3 million unique senior-junior scientist co-author pairs. The authors assess how ostensible markers of career success and the assumed gender¹ of senior co-authors predict junior co-authors’ subsequent citation rates and find that women who publish with women are less likely to be cited. On the basis of these findings, they suggest that both senior and junior women should avoid working with, or being mentored by, other women. Based on correlational and unidimensional data, AlShebli et al.¹ further offer policy recommendations for increasing diversity in science. In this commentary, we first explain methodological problems limiting the validity of the findings, then highlight significant conceptual concerns that undermine the conclusions drawn. We conclude by noting the lack of novelty in what the data *do* suggest about women’s careers in sciences.

Methodological Concerns Limit Validity of Findings

¹ We note that neither the original paper nor this comment can speak to the gender identities of authors within the original study dataset.. Rather, AlShebli and colleagues (2020)—as in much of the scientific literature—rely on *apparent gender* from gender-normative interpretations of individual names, and use the term “gender” to approximate sex assigned at birth (biological male, biological female). We note that neither sex nor gender are binary categories and use the terms “man” and “woman” as shorthand to maintain consistency with the original manuscript. We recognize that both our commentary and the original paper fail to address biases faced by scientists with gender identities outside of the male-female binary, including trans*, genderfluid, and nonbinary scientists. This is a shortcoming that remains critical to address in future work on the interplay between gender identity and scientific career success.

We first address the methodological problems—many of which were noted by the original peer reviewers and were not sufficiently addressed in the published paper—that limit the validity of AlShebli et al.’s¹ conclusions. First, AlShebli et al.¹ define “mentorship” in a manner that is atypical and limited exclusively to co-authorship. Formalized definitions of mentorship exist² and encompass the intentional, holistic development of junior scientists, including the career development skills and psychosocial support that are critical to professional persistence and success. To justify their narrow definition of mentorship, AlShebli et al.¹ report descriptive self-report data from a non-representative sample of 167 volunteers (.006%) of the junior co-authors in the original database. Junior co-authors recalled that senior co-authors conferred tangible skills and career advice, but AlShebli et al.’s¹ analysis did not show that levels of recalled support statistically mediated (i.e., accounted for the association between) the impact of co-authorship on career outcomes. Moreover, assumed gender was neither controlled nor modeled in this analysis. Thus, gender-based differences in perceived support might also shape the association between perceived support on citation rates. As such, the authors are not justified in concluding that co-authorship is tantamount to mentorship nor that it causally predicts career outcomes.

Second, career “success” is defined using a narrow metric that is itself biased by gender. Citation metrics represent only a small portion of scientific findings’ impact,³ and citation rates consistently show stark gender disparities.⁴ The fact that men publish more⁵⁻⁷ are more highly cited,⁴ cite other men more than women⁸, and self-cite more than women^{4,8} is neither controlled for nor explicitly modeled in AlShebli et al.’s¹ analysis. Indeed, men’s gender-biased citation practices⁸ and self-citations⁴ account for gender disparities in overall citation rates. Rather than a straightforward measure of scientific success, AlShebli et al.’s¹ failure to control for gender-

based disparities in publication and citation rates is a likely explanation for their finding that women who publish with women are less frequently cited.

Conceptual Concerns Create Unwarranted Conclusions

Another significant concern of AlShebli et al. (2020)¹ is conceptual. On the basis of narrow definitions and flawed analyses, they make unjustified policy recommendations about who should mentor whom in science. In an attempt to “elevate the status of women,” they recommend that women junior and senior scientists should make efforts to work with men. These conclusions are unjustified based on the data presented.

Furthermore, the way the data is interpreted does not sufficiently account for previously studied systemic, interpersonal, and cognitive mechanisms that impact women’s and other underrepresented individuals’ scientific careers. We⁵ and others⁶ have summarized these evidence-based mechanisms, which range from systemic factors related to societal expectations about gender roles to interpersonal bias to internalized stereotypes and preferences that impact career choices. For instance, relative to men, women scientists *still* do more socially-proscribed, undervalued labor that detracts from research time, including departmental service and formal and informal mentoring of students.^{9,10} Both men and women perceive junior women scientists to be less capable¹¹ and as less “brilliant”¹² despite evidence that their scientific proposals are rated just as highly, if not more so, than men’s.¹³ These mechanisms have predictive power *well beyond* gender disparities in citation rates: Ultimately, they threaten financial security, eminence, and personal well-being for women relative to men in science.⁵ These issues are exacerbated in myriad ways for scholars of color and other marginalized social identities.⁵

Finally, the recommendation that women seek men as mentors as a means by which to achieve gender parity is ahistorical, neglecting the critical benefits of women-women mentor

pairs. In STEM fields, women have been predominantly mentored by men for generations and have only recently begun to achieve parity in career outcomes such as hiring, tenure, promotion, and grant receipt as more women enter the sciences.⁵⁻⁷ Given that STEM fields remain plagued by sexism, sexual harassment, and sexual assault,⁵ women-women mentorship pairs may carry benefits far greater than citation numbers—for example, belongingness, confidence, and psychological safety.^{14,15} Although many men are supportive mentors, there is clear evidence that junior scientists benefit from having role models with whom they can identify. For instance, women PhD students are more likely to opt out of scientific careers when they do not observe women role models who are successfully navigating both scientific careers and family life.¹⁶ Women PhD students working with women faculty are more likely to become faculty themselves.¹⁷ If having a woman mentor makes the difference between a woman staying in science versus choosing another career path, then citation counts are—at best—of secondary concern.

Results, if Accurate, Lack Scientific Novelty

We note that AlShelbi et al.'s results tell us nothing new about accumulated advantage or disparities for under-represented individuals in science. A robust line of previous research indicates that senior co-authors' publication counts,¹⁸ citation rates,¹⁹ collaboration networks,^{20,21} and prestige²² are well-known predictors of junior mentees' future publications, citation rates, scientific networks and prestige. Across all of these outcomes, longstanding gender disparities have favored men⁵⁻⁸ and have been linked to systemic factors, interpersonal bias, and personal beliefs and preferences (see ^{5,6} reviews). Journal pages and scientific investigations aimed at mitigating such disparities should consider and elucidate their ultimate and myriad mechanisms, rather than forwarding flawed conclusions based on insufficient data.

Concluding Comments

It is critical for women and others whose identities are underrepresented in science to play active roles in the scientific community, not just for the sake of idealized equality, but because “in diversity there is epistemic strength.”²³ Science is more valid, innovative, and impactful when diverse voices and views can be developed, promoted, and applied. The recommendations of AlShebli et al.¹ unfortunately do not “elevate the status of women in science.” Instead, they promote questionable results and false conclusions about the mechanisms underlying both individual scientists' success and broader efforts to diversify scientific disciplines.

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