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Commentary

Career trajectories of MD-PhD physician scientists: The loss of women investigators

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Advances in biomedical research require a robust physician scientist workforce. Despite being equally successful at securing early career awards from the NIH as men, women MD-PhD physician scientists are less likely to serve as principal investigators on mid- and later careers awards. Here, Steinman et al. discuss the causes of gender disparities in academic medicine, the implications of losing highly trained women physician scientists, and the institutional and systemic changes needed to sustain this pool of talented investigators.

The increased pace and complexity of bidirectional translational science requires the participation of investigators who are fluent in both basic biology and clinical medicine. Individuals who acquire dual degrees under the auspices of the NIH-funded medical science training program (MSTP) are ideally poised to lead translational research programs. But the supply of physician scientists is compromised by increased attrition of physician investigators, particularly women. Women oncologists report gender inequality in academic medicine, with over 50% of those surveyed convinced that women are less likely to be promoted and 21.9% planning to leave academic oncology within the next 5 years.[1] The loss of these talented investigators negatively impacts cancer research and treatment. Women are less likely to serve as principal investigators (PIs) of late-stage oncology clinical trials, an imbalance that has been linked to fewer women participants enrolled in clinical trials.

Women are also underrepresented in the biomedical literature. Recent studies show that women were the first authors of only 35% of articles published in high-impact (Journal Impact Factor >10) medical journals and were cited less often,[2] resulting in a lower h-index than their male counterparts. Concerning promotion in academic medicine, gender differences are even more stark: only 21% of full professors are women. Women oncologists have called for individual, institutional, and national actions to address gender disparities in academic oncology.[3]

Contributory factors

The loss of talented physician scientists is a manifestation of challenges that women face throughout the academic environment. Factors that contribute to gender gaps in oncology and academic medicine include gender differences in mentorship, sponsorship, funding opportunities, and resource allocation; a paucity of women role models; and the perils of self-promotion for women.

Sponsorship is critical to career advancement. Women physician scientists disproportionately lack mentors to facilitate career opportunities and professional connections. Consequences of reduced sponsorship include a significantly lower number of invitations to deliver talks and participate on panels and fewer nominations for high-profile awards. Less than one-sixth of basic science awards from seven major hematology societies and of Lasker awards since 2013 have gone to women.[4,5]

Programs with a woman physician in a leadership position were associated with a higher percentage of overall women faculty. The proportion of women leaders in academic oncology programs is lower than expected. No woman held presidential leadership positions among 10 major medical specialty societies in the last decade,[6] and only 15% of department chairs are women.

Extramural peer-reviewed funding is required to support research and career advancement. Studies show that there is a gap in funding support for women investigators. Women represent a minority of funded investigators, receive less money than men in the 10 largest grant categories, apply for independent funding at a lower rate, and are less likely to resubmit rejected proposals.

Advancement in academia is bolstered by visibility that relies, at least in part, on skills in self-promotion. Women use more modest self-promotion language on social media. In addition, women risk adverse effects when self-promotion efforts are harshly judged.

The contribution of discrimination and sexual harassment to pushing women physician scientists out of the investigator track is poorly understood but likely significant as demonstrated by the 2018 study by the National Academies, which found that nearly half of women in schools of medicine were subjected to these behaviors.[7] Given the high personal and professional cost of filing an official complaint against a colleague, or worse, a leader in a position of power, women who are harassed often choose to leave.

Trajectories of MD-PhDs by gender

Given these barriers to women persisting and thriving as physician scientists, it is important to assess how training programs effectively prepare women to negotiate the

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physician scientist landscape that they will encounter as independent investigators.

MD-PhD trained physician scientists represent a clearly defined cohort of individuals committed to careers that combine research with clinical practice. MD-PhD graduates of MSTPs comprise 2.5% of medical school graduates but obtain one-third of NIH grants received by MDs. Women and men with MD-PhDs are equally successful in acquiring full-time faculty status. We previously reported the future grant trajectory of 1,015 MD-PhDs who successfully competed for predoctoral NIH (F30) grants using the NIH Reporter database. Women and men trainees were equally likely to achieve mentored (K series) grant funding. However, women MD-PhDs were only 37% as likely as men MD-PhDs to subsequently attain independent R-level NIH funding.[8]

We further examined this cohort, expanding to include 2,307 F30 recipients between 1993 and 2019. As in our prior report, there was no difference by gender in the frequency or time of acquisition of K awards, whereas women lagged behind men in the acquisition of R awards (rate ratio [RR] = 0.63, 95% confidence interval [CI]: 0.47 to 0.84, p = 0.001). We also looked at the rate of receipt of the most senior-level awards (P- and U-grants) by gender. Women MD-PhDs received fewer P- or U-grants (RR = 0.29, 95% CI: 0.13 to 0.65, p = 0.003) than men. This underscores that women leaders with major high-profile grants are scarce.

Out of this full cohort of MD-PhDs who had received predoctoral NIH F30 grants, 632 of them had posted profiles on the LinkedIn professional social media platform. We examined this subgroup in more detail. There was no gender disparity in posting of a LinkedIn profile. The LinkedIn profiles were used to determine attrition from academia, considering industry jobs as an indicator of leaving academia. Of this group, 27.3% of those classified as men and 26.5% as women left academia. Notably, the differences in rates of awards according to gender were similar to that of the whole cohort (Figure 1). This suggests that the disproportionate loss of funded women investigators compared with men is not because women leave academia at higher rates.

Given that women and men are equally likely to stay in academia, women physician scientists must be transitioning from investigation to alternative faculty tracks as clinicians or clinician educators. While these tracks have merit, the overwhelming majority of MD-PhD trainees aspire to be physician scientists and could be shifting their role out of necessity rather than preference.

These cumulative findings indicate an alarming loss of women physician scientists as they progress to independence and thereafter to leadership roles. Below we share a vision to ameliorate this tragic waste of potential and highlight key questions to be resolved.

Systemic approaches to addressing physician scientist gender gaps

All physician scientists confront systemic challenges in sustaining this career path. These include burgeoning clinical, credentialing, and regulatory demands, conflicting performance expectations, inconsistent staffing, gaps in grant support, scattered advocacy, and outdated criteria for advancement. Institutions are approaching these challenges by establishing separate offices for physician scientist career development and guidance and instituting formal mentorship structures. At the same time, bias and other sociocultural forces add to and amplify these challenges for women. Initiatives to support physician scientists that do not address these systemic factors are likely to fall short for women.

Systemic and institutional barriers impact the ability of women to sustain productive careers in academia. Success is impacted by access to start-up funding, space allocation, administrative support, and bridge funding, among other sources of institutional support. Start-up packages are lower for women investigators than for men.[9] We previously reported a qualitative study of men and women in academia from 16 institutions across the United States that highlighted gender disparities throughout the promotion and tenure process.[10] Poorly defined and inconsistently executed promotion, tenure, and dissemination of start-up funding and space risk gender bias to impact these decisions, impeding women's advancement.

Gender parity requires more than grit. Disparities persist despite many outstanding programs that have been developed to advance women through mentoring, skill development, and support including the AAMC (American Association of Medical Colleges) Early and Mid-Career Women Faculty Leadership Development programs, the ASTRO (American Society for Radiation Oncology) Pipeline Protégé Program, and the national Executive Leadership Program in Academic Medicine (ELAM) (https://drexel.edu/medicine/academics/womens-health-and-leadership/elam/about-elam/). More informal online peer-mentorship groups such as New PI Slack and Midcareer Slack and Facebook groups tailored for women academics comprise additional resources to obtain day-to-day guidance for career advancement.

Clinical investigators benefit from NIH Clinical and Translational Science Award (CTSA) programs (https://ncats.nih.gov/research/research-activities/ctsa), which provide intellectual, mentoring, and physical resources dedicated to positively shaping the careers of the 58% of their trainees and 34% of PIs that are women. However, even though all engaged CTSA participants benefit from this program, disparities persist, with women lagging behind men in publications and in applications for and receipt of grants.[11] The disparity was greatest for women early in independent careers, a key transitional point highlighted in the MSTP F30 population as well. Even with excellent training programs women have to manage and adapt in an academic market that poses intrinsic disadvantages.

We believe that the limitations of these faculty leadership and training programs to shift the gender gap in academic success for women to date illustrates the need for system-wide changes in transparency, accountability, equity in policies and practice, and metrics of success. These changes should not put disproportionate burdens on women to organize and implement them.

Transparency and accountability

Institutions can commit to salary equity and monitor their salary structure's short- and long-term impact by gender. This requires collecting, sharing, and acting on data. Institutions should develop and deploy management tools that aggregate and summarize equity-related data in an ongoing, visually accessible way (e.g., dashboards). Such strategies make transparent how gender and minority status match prevailing salary, promotion status, research space, and consensus

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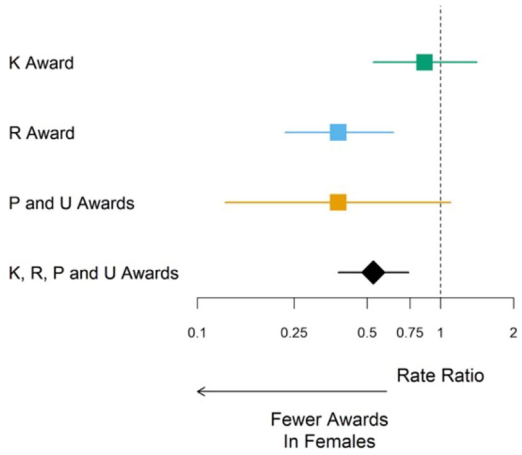

Figure 1. Gender disparity in rate of independent grant awards among MD-PhDs posting LinkedIn profiles

The rate at which women achieved awards compared to men for K-, R-, P- and U- award or for any of these awards was 0.86, 0.38, 0.38, 0.53 respectively. Rates were calculated for the *N* = 652 individuals in the LinkedIn cohort by dividing the total number of awards by the total person-years of follow-up. Follow-up was censored at the earliest of an industry position posting following the date of F award or the end of the study period for those remaining in academia. Rate ratios were estimated using Poisson regression. Scale bars represent 95% confidence interval.

productivity measures. Departmental pay disparities that persist should be elevated to institutional review on an iterative basis. The metrics to determine salaries and bonuses should be transparent and audited.

Data are lacking on whether hiring, research space allocation, administrative support, and/or retention packages differ between equally qualified women and men. We are unaware of quantitation by gender of other measures linked to success including leadership roles, institutional and bridge funding, and nominations for limited submission intra- and extra-mural awards. While anecdotal evidence suggests that women receive disproportionately less advocacy and institutional support, real-time tracking would not only prompt institutional accountability but would also facilitate comparisons between institutions.

A gender equity initiative at Johns Hopkins University School of Medicine was analyzed 11 years after implementation to model long-term salary implications. While the initiative only partially ameliorated salary disparities, the effect on lifetime wealth and savings was substantial.[12] We recommend that institutions adopt such gender equity tools to project the impact of their initiatives over time.

Accountability includes transparency in reporting gender bias or harassment in the workplace. Title IX of the Education Amendments Act prohibits educational institutions receiving federal funding in the US from sex discrimination. While Title IX offices receive harassment complaints, many instances are not reported. Regular assessment of the prevalence and impact of microaggressions at the trainee and faculty level should be conducted and results monitored. Mandatory educational programs raising awareness of microaggressions and their impact on women physician scientists can engender a more positive environment and generate a culture in which individuals can report without fear of retaliation.

Equity-promoting policies and practices

Institutions should ensure that women are at the table when recruitment and promotions are decided, when salary metrics are discussed, and when decisions are made that prioritize clinical and research goals.

Women in academia disproportionately contribute uncompensated time including service and teaching. Time availability particularly impedes women physician scientists. Innovative models to protect research-related time are needed, such as a time-banking program piloted at Stanford.[13] That program matched team- or mission-directed time commitments with credit for support services at work or home. It is notable that women accrued credits at twice the rate of men because of the disproportionate time that they had devoted to service and teaching. Participants reported subjective benefits and 30% more grant funding than matched controls. Beyond such initiatives, metrics for success and promotion should appropriately value service and teaching. Salaries should capture effort from service and teaching tasks.

To protect research, institutions should embrace realistic milestones that are fairly compensated. More flexibility can be introduced into rigid frameworks for academic success to recognize distinct gender and life stage needs and contributions. Institutional efforts can do much more to identify, understand, and increase the promotion of women physician scientists independent of those individuals' efforts.

Many academic medical institutions have initiated task forces on women's academic careers, leadership development programs for women, or women-specific mentoring groups. These activities to build women's skills do not obviate the responsibility of institutions to devote the expert resources and commitment to surveil their policies and practices and to take needed actions to ensure equity.

Shared responsibility

National progress toward equity is a shared responsibility. Accrediting bodies should be engaged in the dialogue that prioritizes, measures progress toward, and frames a timeline toward gender equity. Funding agencies can elevate gender disparity research in their portfolio. The NSF (National Science Foundation) ADVANCE grant supports investigations of STEM (Science Technology Engineering and Math) academic culture and institutional structure that may differentially affect women faculty (https://new.nsf.gov/funding/opportunities/advance-organizational-change-gender-equity-stem). As such, ADVANCE is an integral part of the NSF's multifaceted strategy to advance the status of women in science and engineering. An NIH-supported version of the ADVANCE grants could support research in evidence-based practices to overcome gender, racial, and ethnic inequities in academic medicine.

We must address the knowledge gaps hindering the progress of physician scientists, particularly women. Factors linked to the lower the rate of independent grant

applications by highly qualified women need to be identified. There should follow a strategic plan for building the application base in a gender-equitable manner.

Identifying how to develop and scale best practices to bolster the success of women physician scientists is likely to help those facing barriers and bias in academia for their race, sexual orientation, and gender identity[14,15] and those facing intersecting bias. Changes enacted to help women physician scientists are most durable if the benefit also extends to other groups.

Conclusions

MD-PhD physician scientists are ideally poised to lead studies that change our understanding of disease and the practice of medicine. Amidst this promise, there are many challenges to persistence in this career with a disproportionate loss of talented women MD-PhDs. Even while women MD-PhD trainees are as successful as their male counterparts in securing funding as trainees and junior faculty, they are missing from the ranks of NIH-funded established investigators. Women physician scientists are disproportionately leaving the investigator track. The circumstances associated with this exodus are poorly understood. However, the consequences of this loss of talent are likely substantial. The drive to gender equity is taking too long. It is time for institutions and the biomedical enterprise to put octane in the tank.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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