


Dismantling barriers faced by women in STEM

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Governments worldwide are committing more funding for scientific research in the face of the ongoing pandemic and climate crises. However, the funding process must be restructured to remove the barriers arising from conscious and unconscious biases experienced by minoritized groups, including women, and particularly women of colour.

The gender disparity in research funding, particularly in science, technology, engineering and mathematics (STEM) subjects¹, is often explained by women applying less often and for smaller sums than men. However, data on allocated research funding shows that women win fewer grants and are awarded proportionately less of the requested sum than men when applying for grant funding. In 2016–2017, for example, one of the largest funding bodies for STEM research in the UK, the Engineering and Physical Sciences Research Council (EPSRC), awarded fewer than 7% of all research grants to teams led by women². On average, grants awarded to women were less than 40% of the sums received by their male colleagues. In total, £944 million was awarded to projects led by men compared with £69 million to research led by women³. Whilst in the UK, women are marginally better represented as Principal Investigators (PIs) in biology and medicine (leading 22% and 35% of projects funded by the Biotechnology and Biological Sciences Research Council and the Medical Research Council, respectively, in 2018–2019), the number of women PIs is very much lower than the number of women attaining degrees in these disciplines⁴.

The inequities in research funding are in no way limited to the marginalization of women. Funding inequity (Box 1) also has a detrimental impact on those who are marginalized through other characteristics, such as their disability, race and ethnicity^{5,6}, and many women's identities mean they experience these multiple impacts. A research funding system that excludes a large proportion of active researchers in this manner is simply unfair. In addition, it also results in a critical loss in productivity and innovation, especially considering that students from minoritized groups have been shown to innovate at higher rates than their peers from over-represented groups, although their findings are more frequently overlooked⁷. A more inclusive research funding system could benefit not only these groups, but also broader society by leading to increased innovation, better decision-making and problem solving, and more productive organisations⁸.

Because of the importance research funding plays in the promotion process to senior positions in academic and research careers, funding inequity also contributes to the lack of retention and progression of marginalized groups, including women – particularly women of colour – in their careers. In turn, this drives the gender and race pay gaps in academia.

In the UK, gender equity has been given increased prominence in the policy agenda due to initiatives such as the Athena Swan Charter,

BOX 1

Equity vs. equality

The goal of funding policy should be achieving equity, as distinct from equality. Equality implies that individuals or groups with different characteristics are given the same resources or opportunities. Equity recognizes that minoritized people may face specific barriers or challenges and hence require appropriate resources and support to allow them to enjoy the same outcomes as their non-minoritized counterparts. For example, a funding body that asks all candidates to attend interviews in person in order to win grants may be treating everyone equally. However, organizing travel to such an interview is more challenging if you are disabled, or the primary carer of a young child (a role which is more likely to be held by women). Hence, such funding opportunities are likely to be more easily accessible to non-disabled men than their minoritized counterparts. This policy would thus be inequitable unless appropriate adjustments were put in place.

which recognizes and accredits institutions that demonstrate commitment to promoting women's careers in STEM. Unfortunately, this has led to narrow definitions of equity and inclusion; a recent review⁹ of the scheme showed that it disproportionately benefited white middle class women¹⁰ and failed to address how other aspects of identity – such as race, dis/ability, sexuality and socio-economic status – contribute to the ways in which we experience the systems within which we operate. The intersections of these multiple aspects of identity have also been neglected in attempts to understand the systemic nature of research funding inequity.

White women have seen the greatest benefits from academic gender equality initiatives, but the sector has not even succeeded in addressing the challenges they face, let alone dismantled the barriers faced by those living at the intersections of marginalized identities. Progress towards parity of representation in STEM has been glacial. For too long, our approaches to increasing diversity in science have focused on changing individuals rather than the systems that limit them – a 'fix the women' ethos. Workshops that aim to teach women how to dress, speak, advocate for themselves or 'lean in' ignore the real issue: it is not women who are broken, but the systems which place unfair and unnecessary barriers in their path. Here, we present an overview of the systemic barriers related to research funding and propose measures designed to address them.

Funding vital scientific research has been central to fighting the pandemic, and the fact that this has prompted governments worldwide to commit to increase research funding budgets^{11–13} also provides us with an opportunity to restructure our funding processes. Removing the barriers that women face in our funding systems, within a situation with a fixed pot of available funding, could easily be regarded as a

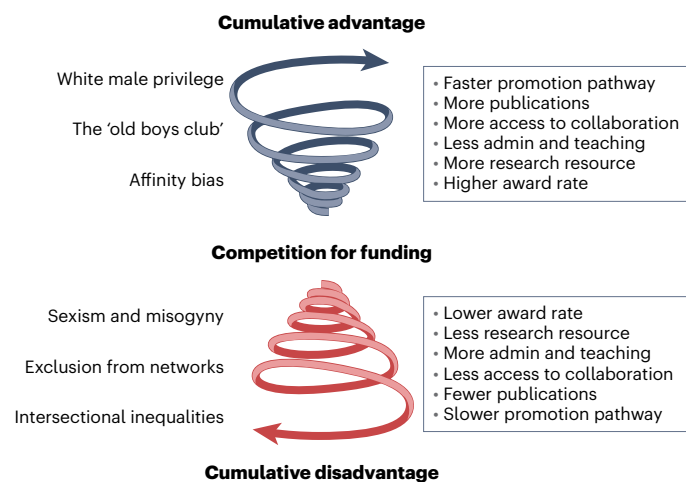


Fig. 1 | A schematic representation of the Matthew Effect. Inequities are perpetuated when, for equally qualified applicants of different genders, funding is more likely to be awarded to a man than to a woman due to biases and systemic barriers. Such unjust funding decisions have a knock-on impact in multiple aspects of the funding applicants' research careers.

threat by the currently dominant demographic group. Put more simply: more funding for marginalized groups, including people of colour and women of all ethnicities, out of a fixed total, must necessarily mean less funding for the over-represented group (cis-gendered, heterosexual, non-disabled white men). We should not then be surprised if those men do not all rush to support such a change. However, with the value of science to our society clearly demonstrated by the pandemic response, the time is ripe to increase science budgets, making available a bigger pot of funding, and creating space for increased diversity in our researcher population without this being perceived as unfair by any group. Funding policies and processes must be reformed to embrace this opportunity.

Breaking the cycle of cumulative disadvantage

One of the largest drivers of gender inequity in research funding is the notion that past achievements should be used as a reliable indicator to judge future potential in grant funding applicants⁸. This phenomenon of accumulated advantage is often referred to as 'The Matthew Effect' (Fig. 1). When two equally qualified grant funding applicants compete for funding and one wins and the other loses out, the applicant who secured funding is more likely to keep winning funding in the future, so that the second is left ever further behind. The Matthew Effect perpetuates funding inequities in research funding because track-record emphasis is a vessel for bias. For example, men's higher grant funding award rates (Box 2) have been explained by men being marked higher on criteria for the "quality" of the researcher. Yet research outputs used to indicate such quality include track record of grant income, but also collaborations, publications and invited talks – all measures of career and research success that have been found to carry bias against women¹⁴. The effect of this accumulation of disadvantage is evident in a recent report from the Engineering and Physical Sciences Research Council on gender in their grant portfolio¹⁵, which sees men's award rates being equal to those of women for small awards, but almost three times greater for the largest awards, with – in particular – a massive 75% of men's applications for amounts

BOX 2

Award rate vs. success rate

In this article, we use the term 'award rate' for the proportion of submitted funding applications that are awarded funding. Elsewhere, the term 'success rate' might be used. We choose to use award rate because this puts the onus of addressing differences in that award rate between men and women on the organisations who do the awarding: the funders and their systems. Too often, we see suggestions that low success rates amongst minoritized applicants for funding are because of the behaviour of the minoritized people – such as their choices of research area and their use of language. We want, instead, to stress the role of systems and policies in limiting the opportunities for minoritized people to be awarded funding. We note that our terminology is also consistent with the current practice of the main UK research funder – UK Research and Innovation (UKRI).

in excess of £10 million leading to awards. This can straightforwardly be interpreted as the career-spanning impact of bias on today's most senior women scientists.

Women, and most particularly Black women^{3,16}, who work in science in the UK report workloads with larger proportions dedicated to teaching, as well as administrative, and organizational service tasks (for example, committee work, pastoral support and recruitment)⁸. With less dedicated time than their male colleagues to bid for research funding from a system which is already biased against them, women are then more vulnerable to further increases in non-research workload tasks as a result of not securing research funding⁶, which in turn perpetuates a continued reduction in women's likelihood of being awarded grant funding.

The COVID-19 pandemic has caused a shift in academic and research institutes in many countries, resulting in a significant and stepwise increase in teaching and administrative workloads³. With the additional tasks of redesigning coursework and covering for the redundancies of teaching staff, these impacts have been acutely felt by staff who are on short-term contracts, junior faculty and/or in probationary (tenure-track) stages. This burden must be viewed as disproportionately impacting women, given that the majority of women in academia are in either fixed-term or junior faculty roles. Compounding this impact, women have also had to shoulder a higher level of domestic responsibilities such as parenting (including home-schooling and childcare during lockdowns), household chores, or caring for elderly and/or disabled family members^{17–19}. Even among women, the impact of domestic burdens on academic productivity are particularly felt by women of colour²⁰. These additional burdens will have an impact on opportunities to accumulate advantage in the workplace.

One option to disrupt the current system's cumulative bias is the 'Universal Basic Research Grant'²¹. In this system, all researchers who are currently eligible to apply for research grants would be provided with a basic allocation of funding each year – sufficient to ensure they can maintain a small research team and keep their work ticking over. Hence, they would be able to collect pilot data and maintain a meaningful ongoing research programme even across a short funding hiatus if they are unsuccessful in winning competitive funding. This would

reduce the requirement to develop and write research proposals, shrinking the excessive workloads in academia, creating benefit across the board, but particularly for women, whose time is inequitably loaded with administrative and domestic tasks. It would provide flexibility to everyone at times of crisis so that in a future pandemic, for example, the inequitable impact of such crises on women would be reduced.

Social capital leads to funding capital

Building a research reputation is a crucial component that contributes to successfully winning research funding. Access to networks and the opportunities therein is a key component of a researcher's social capital (which, in this context, may be defined as the actual or potential resources, support, and related opportunities gained from access to social networks). In training for a research career, women have reduced access to training and inclusion in 'elite' labs – men who win major funding and prestigious awards, or who are elected into prominent professional bodies, are significantly less likely to include women in their research projects²². Across disciplines, young women especially are less likely to be included in international collaborations²³.

Women have fewer industrial partners, network more locally, with less opportunity to make strategic connections, and are provided with less institutional resources to enable such connections⁶. Especially in STEM, women have reduced access to exclusive social and decision-making networks^{7,24} – all leading to reduced social capital compared with men. Women also publish less for several reasons, including higher non-research workloads and leaking out of the academic career pipeline. Articles written by women are more likely to get rejected during peer review^{25,26}. Men, and particularly white men, who win grants are less likely to include women as co-authors on publications⁸. Track-record evaluation processes also disproportionately penalize researchers from less traditional career paths, such as those returning to academia after a taking a period of leave, interdisciplinary researchers, and those on flexible and part-time contracts⁸. A review of more than 1.2 million doctoral theses demonstrates that women and people from other marginalized groups produce higher rates of scientific novelty, but their contributions are taken up to a lesser extent by senior scholars belonging to gender and ethnic majorities⁷.

Institutional gatekeeping

Within institutions, in addition to a lack of support – or even active discouragement – from line managers and research Deans, formal internal review systems can operate as a gatekeeping barrier for women who want to apply for research funding. An internal triage system is used by many universities and research institutes to select which proposals to put forward for submission to external funding bodies, and for certain funding schemes, there are specific limits on how many applications an institution may submit. Most grant applications require an institutional sign-off and letter of institutional support from someone in a senior position. Sourcing this support often requires the aforementioned social capital that is disproportionately afforded to men. Combined with the significant scope for bias in choosing which researchers to put forward from the institutions, this poses a powerful set of institutional barriers for women in the processes of applying for grant funding. The discretion that the universities are allowed throughout the application process, their lack of accountability to ensure diversity among funding applicants and their total immunity from scrutiny or data collection on this issue remain major reasons for the inequity in funding allocation by UK Research and Innovation (UKRI) and charity funders. Under pandemic-induced hiring freezes, sponsorships for external fellowships

BOX 3

Positive action vs. positive discrimination

In the UK, positive discrimination – treating one person more favourably than another because they are a member of a minoritized group – is unlawful. Positive action, however, does not seek to discriminate in favour of minorities. Rather, it aims to lessen disadvantages or remove barriers faced by minoritized people. For example, an employer might offer junior academic staff from minoritized groups an opportunity to receive mentoring on how to structure a promotion application, in order to increase their confidence in the promotion process and reduce the impact of limited access to networks. Positive action is entirely lawful and indeed necessary to achieve fairness.

(through triaging at the discretion of the departments or senior academics) have become the only mode of recruitment for research-active faculty positions in academic institutes. There is a real concern that this could lead to early-career women, particularly women of colour, being increasingly overlooked in faculty recruitment.

Incentivizing inclusive recruitment, retention and promotion practices

The implementation of a Universal Basic Research Grant system, as proposed above, will only be effective to reduce inequities in the long term if scientists from minoritized groups are able to progress up the academic career ladder, to positions where they are allowed to lead research groups and be in receipt of this guaranteed funding. This would place an onus on Universities and Research Institutions to improve their recruitment, retention and promotion of scientists from marginalized groups. It would be vital to incentivize such improvements as part of the restructuring of the funding system. The long-term aim should be to appoint women to half of permanent faculty positions within an agreed timescale – this could be seen as the gender equity equivalent of achieving net zero. This approach should be established to increase the representation of all marginalized groups. Governments, or their funding agencies, would need to take responsibility for monitoring the demographics of the researchers at each university that qualified for Universal Basic Research Grants, and to provide additional funding opportunities to institutions who succeeded in increasing the diversity of their academic researcher cohort.

This proposed approach is similar to one that has been successfully implemented, on a small scale, by the Royal Academy of Engineering as a positive action (Box 3) in their Research Fellowship programme. Universities are only allowed to put forward three candidates for Fellowships each year, but an extra application is allowed if at least one of the applicants is from a group which is under-represented in the relevant engineering discipline. According to Christina Guindy, Head of Research at the Royal Academy of Engineering, more than 29% of these fellowships are now held by women. Whilst research is ongoing to investigate whether this is directly linked to the positive action the Academy has undertaken, this figure alone is impressive, given that the proportion of women amongst undergraduate students taking

engineering and technology degrees in the UK is almost a factor of two lower, at 17.01% (ref. ²⁷). The goal of incentivizing universities to increase the diversity of those applying for and receiving research funding has the potential not only to improve representation amongst grant awardees, but also to alter hiring practices, creating a step change in attitudes across the research ecosystem.

The pandemic has also exacerbated funding inequities, and we have seen a starker exclusion of women from funding opportunities²⁸. A study at the University of Liverpool compared UKRI funding applications in the second quarters of 2019 and 2020, and showed that whilst application rates dropped for both men and women for the 2020 period, the decrease in applications from women was more than twice that of applications from men²⁹. Refusal by funders (including UKRI) to exercise flexibility in grant application deadlines, exclusion of minoritized groups – including women of any ethnicity – from speaking opportunities in webinars and online conferences³⁰, and overlooking women's achievements in awards and honours³¹ are examples of worsening exclusionary practices in academia. This exclusion of marginalized researchers has continued, and indeed grown, in spite of ringing statements from funders about their commitment to equity. This suggests that funders cannot be trusted to police their own practices, but that mandatory external scrutiny of their policies is required to ensure transparency and accountability.

More than two years after the start of the pandemic, we are yet to see a systematic review in the academic STEM disciplines and the higher education sectors on its differential impact on minoritized groups – including women of all ethnicities, scientists of colour, disabled people and members of the LGBTQ+ community (people of marginalized and/or persecuted sexual orientations and gender identities) – or a strategy to level the playing field. The additional inequities arising from the pandemic have been exacerbated by failures to address the ongoing rise in hate speech and racism in universities, professional and public bodies compounding the emotional burden for groups including transgender women, non-binary and gender-diverse people, and Black women in the academic community. A charitable view might be that the pressures of the pandemic have distracted academic leaders from taking action on inequity. It is vital that the sector refocuses on these issues rapidly.

Overall, to remove the negative impact of our funding processes on equity in science requires action from governments, funding bodies and academic institutions to achieve significant systemic and structural change. Introducing a Universal Basic Research Grant is one possible, radical – yet feasible – approach to achieving this change, and would need to be accompanied by other improvements to policy and practice such as increased use of anonymized applications in competitive funding schemes, and elimination of gendered and other discriminatory language in funding calls⁸. All these changes require independent oversight, mechanisms for accountability and long-term monitoring of their impacts.

Without far-reaching systematic change addressing both the broad sweep of policy and the key details of funding processes, not only will women continue to lose out in hypercompetitive and biased funding competitions, but science will also suffer from the loss of their innovative ideas that never get beyond the rejected proposal folder. Whilst we passionately believe that fairness should be a sufficient motivator to remove the inequities in our current systems, governments and funding bodies should also be aware that evidence²⁴, that shows

that greater diversity in the researcher community leads to greater innovation and impact in the research performed, is accumulating. Our current system, riddled with inequities, leaves everybody poorer. Change is urgently needed.

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Competing interests

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