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Review of barriers women face in research funding processes in the UK

Julie M. Jebsen, Cathy Abbott, Rachel Oliver, Erinma Ochu, Izzy Jayasinghe & Caroline Gauchotte-Lindsay

In the UK, women are underrepresented at the highest levels of academia in all subjects but nursing, but particularly in science, technology, engineering, and math (STEM) (Advance HE, 2018). Research, and the funding that enables research, is a critical point of career progression. Women apply less often and for lower amounts of funding, and are less successful than male colleagues (UK Research and Innovation, 2018). The common explanations given that women have to apply for more, and more often, do not sufficiently explain the gender disparities in research funding. This review critically evaluates some of the barriers and biases women face in the process of applying for research funding in the UK. Institutional barriers such as women carrying a heavier burden of teaching and academic citizenship, and lack of support, mentoring and visible role models impact on women's success in securing research funding. Systematic barriers exist at many levels, particularly for parents and carers. These range from the impact of taking maternity leave, to grant deadlines falling during or shortly after school holidays and the requirement to travel for interviews. The focus on track record in grant review, biased language used in evaluation materials and unconscious biases on the part of reviewers further impact differentially on women. Lack of freedom to travel, and thus to network or attend conferences can result in exclusion from multi-national networks and the ability of parents to demonstrate an international profile. The policies and practices that impact on the ability of women to secure research funding must be reviewed and addressed with urgency for the benefit of the research community as a whole.

WOMEN are underrepresented in science, technology, engineering, and mathematics (STEM), with increasingly lower representation from school through academic careers to Professorial level (Blickenstaff, 2005). Eagly and Carli (2007) argues that addressing the problem of recruiting, retaining and progressing women at all career levels in STEM is important as a moral value, and beyond that, increasing women's participation in a labour market dominated by men could be worth between £15 to 23 billion (Women and Work Commission, 2009) to the UK economy. Meta-analyses of evidence that women do not succeed to the same extent and pace as their male equivalents show that this is not due to gender differences in intelligence or ability (Hyde, 2005, 2016) or even, contrary

to popular belief, to motherhood, but rather that the difference in academic career progression between men and women is a result of socially interpreted, cultural differences (Kandola & Kandola, 2013; Santos & Dang Van Phu, 2019; Peel, Schlachta, & Alkhamesi, 2018; Thanacoody et al., 2006). These differences become particularly acute for black and ethnic minority women (Jones 2006; Rollock, 2019; Royal Society, 2014), for those with disabilities (Brown & Leigh, 2018; Royal Society, 2014), and those who identify as LGBTQ+ (Gibney, 2019; Wellcome, 2020) as these marginalised groups face further systemic discrimination and career attainment gaps. We note in particular that there is very little data available in the literature or elsewhere on funding disparities faced by those whose gender identities are

non-binary, or those who are trans. Intersectionality is a term which was originally coined to describe the ways in which race, gender and class combine to multiply barriers in the workplace for black, working class women (Crenshaw, 1989). This extends to academia and STEM in particular. For instance, in 2019, only 35 out of 19,285 UK professors were Black women (as identified by The Higher Education Statistics Agency – HESA). Indeed Black women are three times less likely to be professor than White women and half as likely as Black men, demonstrating the compounding effects of intersectionality.

The aim of this literature review is to critically assess the systemic barriers and biases that affect women in the processes relating to applying for and obtaining research funding, a key factor in career progression in STEM academia. Taking an intersectional approach to examining these barriers allows us to take into account how ‘race/ethnicity, class, gender, sexuality, religion, citizenship, ability, and age’, shapes the ‘structural dynamics of power and inequality’, including within academia (Tefera et al., 2018).

Gender differences in research funding

Research on gender disparities in STEM research funding applications and awards indicate that women apply less often and for lower sums, and are less successful and awarded less of the requested sum than their male colleagues (Eloy et al., 2013; Waisbren et al., 2008). Across career stages, women are listed as Principal Investigators (PIs) less often than men (Ley & Hamilton, 2008). In the UK, a freedom of information request reported by the Guardian showed that in 2016 to 2017 (Weale & Barr, 2018), fewer than 7 per cent of all Engineering and Physical Sciences Research Council (EPSRC) research grants went to teams led by women, with the average size of grants to women being less than 40 per cent than that of their male counterparts. This culminated in £944m awarded to projects led by men compared to £69m to projects led by women.

EPSRC explain these numbers as being skewed because of a number of very large grants awarded to male principal investigators (Weale & Barr, 2018).

Further reports indicate that the notion that gender differences in research grants can be explained by women applying less often and for smaller amounts of money in fact overestimates the proportion of funding disparities that can be explained by female application rates. When total numbers are reported yearly by UK Research and Innovation (UKRI), for EPSRC in particular, the data suggest that 1) the proportion of women applying is close to the equivalent academic population in that subject (as identified by The Higher Education Statistics Agency – HESA) for a given field and 2) success rates for men and women are equivalent. However, this way of reporting data can conceal the discrepancies in terms of amount of funding and prestige of grant. For instance, over the last three reported years of programme grants, a scheme described by EPSRC as awarded to world-leading research groups to address significant major research challenges (EPSRC, 2015, 2016 and 2017), only two of the 41 awards were made to women PIs: 2017, 51.3m programme grant funding awarded in total, one woman/10 awardees, 11 per cent of the funding; 2016, 94.3m total 1/19, four per cent; 2015 56.5m 0/12, 0 per cent. This is a real concern as the direction of travel of funding strategy has been towards more large projects and fewer smaller ‘responsive mode’ activities (i.e. projects instigated purely by the PI).

Whilst the situation in medical and biological sciences research councils is less dire, there is still real cause for concern given the healthier gender balance (Royal Society, 2014) at all early career stages. Data for grant applications to the Biotechnology and Biological Sciences Research Council (BBSRC) in 2016-17 show that only 26 per cent of applications and only 23.5 per cent of grants awarded were led by women, whereas (according to BBSRC’s interpretation of

HESA data) the applicant pool is around 37 per cent women (UK Research and Innovation, 2018). In 2017/2018, only nine out of 50 applicants to the prestigious Medical Research Council program grants were women. These are the few examples that the authors were able to gather based on data published by funders. The lack of granularity of these data does not allow analysis of intersectional effects but even larger funding disparities have been reported for other marginalised groups, notably BAME STEM academics, and cumulative effects are certainly expected (UKRI, 2020).

Bias in research funding awards is detrimental to individuals because it constrains the research they can engage in, and their career progression and longevity, with grant income being a key selection criterion for senior roles in academia (Lopez et al., 2014). There is an acknowledged 'Matthew effect', where past success is a positive indicator for future success (Merton, 1968), in academic grant funding (Bol et al., 2018) that further penalise disadvantaged groups. Organisations and society also lose out when research funding is not awarded more fairly and broadly because a big section of the potential population that could contribute to research and innovation are denied the opportunity. Bias towards researchers who are typically underrepresented in grant winners is identified as resulting in critical loss in productivity and innovation (Kumar, 2014). Diversity enhances creativity, and encourages the search for original information and perspectives, which in turn leads to better decision making and problem solving (Phillips et al., 2014). Saxena (2014) argues that diversity is a strength for any organisation, and if managed properly, can increase the productivity of that organisation.

Institutional barriers to applying for funding

The first hurdle in receiving funding is making an application. There is much anecdotal evidence that women are more likely

to be discouraged to apply to large schemes by their line manager/research deans, but in a more tangible way there are also demonstrable institutional barriers to application.

Firstly, scientists who are women in the UK reported a heavier teaching load than their male counterparts, and also dedicate more time to outreach (Gibney, 2017). They also shoulder more of the citizenship and administration load (Guarino & Borden, 2017). The consequences of this is that they have less time to dedicate to research. For example, academic women carry a disproportionately heavy load of equality, diversity and inclusion (EDI) work and other service tasks that can be considered 'token' service. By carrying workloads with more service tasks, women have less time to dedicate to bidding for research funding, further endangering their chances of funding success (Misra et al., 2012; Mitchell & Hesli, 2013). This effect is amplified as women progress in seniority (if they do), as lower numbers of senior female academics means that they will sit on more committees than men when there is a deliberate effort in balancing gender representation (Hyde, 2017). In turn, lower success in securing funding leads to an increased teaching and citizenship load (Weale & Barr, 2019), perpetuating the downward spiral effect that prevents women from securing grant funding. Here again, women at intersections suffer heightened effects; for instance, black women have reported both heavy workload and heightened levels of scrutiny compared to their white counterparts which are further barriers to developing research capacity (Jones 2006; Stockfelt, 2018; Wright et al., 2007).

Secondly, internal review systems can act as a direct barrier for women applying for funding but are difficult to evidence. Many universities operate triage systems, sometimes instigated by the funding scheme (e.g. the UKRI Future Leader Fellowship), to pre-select the proposals for submission. Whilst most grant applications require some institutional sign-off, the practice of internal

trriage is particularly important where letters of institutional support (often high level) are required. This inevitably requires both self advocacy and institutional support. Imposter syndrome, 'the internal experience in which the individual believes they are not really bright, despite being a high achiever and of high intellect' (Howe-Walsh & Turnbull, 2016, p.418) is a recognised phenomenon in the highly competitive academic environment and is pervasive amongst women in STEM (Bravata et al., 2020; Howe-Walsh & Turnbull, 2016; Vaughn et al., 2020) and is believed to be associated with their othering in male dominated environments. Thus it is not unreasonable to assume that imposter syndrome makes self advocacy and self promotion more challenging. Even when they do advocate for themselves, women are likely to encounter benevolent sexism, notably in the form of protective paternalism when men want to spare women disappointment of a funding rejection (Maldonado & Draeger, 2017). It is all too easy for department heads, for example, to tell applicants that they are 'not quite ready' to apply for Fellowships. When the Investigator Awards replaced the previous Wellcome project grants in 2010 with a more minimal application (focused on past record rather than future plans) that nevertheless required high level HEI support and an interview, the proportion of women achieving an award over the first three years was ~16 per cent, as compared with ~26 per cent of project grant awards being made to women over the previous three years (Wellcome, 2018).

Generally, in male-dominated environments, women report being less supported in their research by their institutes, schools and faculties (Moss-Racussin et al., 2012; Shen, 2013). Women in Science and Engineering also report a lesser sense of inclusion and helpfulness from permanent staff in their departments, and less recognition for their accomplishments (Fox, 2010). Compounding, academics with health conditions identify concerns that their academic

achievements are judged through the lens of their disability (Brown & Leigh, 2018) while BAME academics describe negative assumptions being made on their abilities (Wright et al., 2007; Rollock 2019). Finally, beyond lack of support and recognition, transgender women face, in the STEM academic work place, the largest amount of offensive, intimidating, exclusionary and harassing behaviours of all LGBTQ+ groups, with 20 per cent regularly considering leaving the profession (Institute of Physics, Royal Astronomical Society, & Royal Society of Chemistry, 2019).

A lack of visible, senior, female role models and mentors can also be interpreted as a longstanding barrier for junior women (Levinson et al., 1991; Vokić et al., 2019) and the gender disparity in funding is at risk of becoming self-fulfilling. Essentially, environments that are not actively inclusive, do not nurture women's ambitions actively and overlook the profound additional barriers to people at the intersections of marginalised groups, effectively reduce the probability of women securing grant funding.

Systemic barriers in the funding process

It is difficult to track why, how and by whom the established process of grant review was designed but it does not appear that it was evidence-based to reduce or even eliminate bias. Indeed, one might argue that, to the contrary, the processes effectively favour a demographic of white cisgender able-bodied men who are not primary carers for children or elderly parents, the demographic that once completely dominated academia and is still the majority. The move by funders over the past 10 years towards giving more money to fewer investigators to support 'the brightest researchers with the best ideas' (Chemistry & Industry, 2011) is further advantaging this demographic as they benefit from overt and covert biases.

Funding the 'brightest researchers', 'applicants who are recognised to be of the highest standard relative to their career stage and on a trajectory to become

world-class' (UKRI, n.d.) puts an important emphasis on the track record of applicants. This emphasis on the track record in grant review has been identified as a significant stumbling block to women seeking funding, as highlighted by focus groups discussing challenges faced by women in applying for and being successful in obtaining BBSRC grant funding (McAllister et al., 2015). Track record is a vessel for bias. In a review of the application and materials of three large grant calls, van der Lee and Ellemers (2015) observed that while the assessment of the quality of the proposals were not statistically significant between men and women, the higher success rate for men was explained by their statistically higher score for the 'quality of the researchers' criterion. Based on previous studies, van der Lee and Ellemers (2015) likely discounted a real gender difference in productivity (such as number of publications and citations) and attributed the disparity to implicit bias brought on by heuristic approaches in reviewing large numbers of grant and possibly the use of masculine-gendered language in instruction and evaluation sheets, which were easier to match to stereotypical qualities of male applicants. Indeed, 20.8 per cent of funding documents analysed by van der Lee and Ellemers used gender exclusive language such as only using pronoun referring to one gender ('he') rather than gender inclusive use of pronouns ('he or she', or more inclusively 'they') and 86.2 per cent emphasised masculine-gendered words such as 'challenging', 'independent', and 'adventurous' rather than feminine-gendered words such as 'responsible', 'organised', or 'thorough'. Witteman et al. (2019) also found that when women are listed as PIs, they are less likely to be successful, whilst being more likely to be evaluated on the basis of their personal record, rather than their proposed research. When it comes to people reviewing academic performance and standards, the literature is rich with examples of implicit (Frith & Frith, 2008) gender biases, ranging from students'

bias towards female teaching staff (Boring, 2017) to Professors' biased evaluations of post-docs (Eaton et al., 2019), that corroborate these findings for grant evaluation.

However, it must also be acknowledged that track record evaluation perpetuates the effects of bias that starts well before grant application (Knobloch-Westerwick et al., 2013) and therefore it is possible that at equivalent career stage (year post-PhD), women's track records are less attractive. Systemic and implicit biases mean that women face more barriers in developing their track record than men (Forret & Dougherty, 2004). For instance, women are less likely to have been trained in elite laboratories, especially those led by men (Shelzter & Smith, 2014), are less likely to receive support and mentoring (Moss-Racussin et al., 2012; Shen, 2013, Eaton et al., 2019) and women-led publications take longer to publish (Hengel, 2017; Day et al., 2020) and are less cited (Lariviere et al., 2013). International collaborations and their outputs are also strongly associated with higher impact and citations (Lariviere et al., 2013) and therefore stronger track records, yet women are less likely to co-author such publications in science. This is partly because women are PIs less often, but also because male PIs are less likely to publish with female authors (Salerno et al., 2020). Industrial collaboration is also strongly correlated with research impact and thus international profile; however, female academics are likely to have fewer industrial partners, particularly in male dominated sectors (Tartari & Salter, 2015). Evidence strongly suggests not that women collaborate less, but that they collaborate more locally and less strategically and are held back by gendered institutional barriers (Fox et al., 2016; Zippel, 2018). The existence of 'male networks' in academia and industry for STEM disciplines (Howe-Walsh & Turnbull, 2016) are more difficult for women to break into, particularly as they are supported by a masculine culture of business travel. Research indi-

cates that regardless of family situation, men travel considerably more than women for work, and that men's career progression benefits from work travelling (Gustafson, 2006). In academia, international travelling, until the 2020 Covid-19 pandemic and despite a pressing environmental agenda, was widely perceived as the only way to build or as an evidence of international recognition (Eriksson et al., 2020; Storme et al., 2013, Storme et al., 2016). Globally, female academics are less likely to be invited as speakers or panel members at conferences (Casadevall & Handelsman, 2014; Yong, 2017; Morehouse et al., 2018). In 2015, Greg Martin (Bacon, 2015) developed a formula for calculating the probability of getting an all-male panel. Although all-male panels are common in STEM conferences, particularly in subjects where women are the most underrepresented such as mathematics, Greg Martin argues that if speakers were chosen in a way in which gender was not a factor the probability of having no female speakers or panel members is less than five per cent (Bacon, 2015). Women in academia therefore have a harder time raising their 'international profiles', with women at the intersection with other marginalised groups facing the greatest challenges, this indirectly skews gender representation in grant awards (particularly for large grants) as it is an important criterion of evaluation.

Track record evaluation is also perceived to penalise researchers with 'non-traditional' career paths (McAllister et al., 2015) such as long-term sick leave, discipline-hopping, parental leave, flexible, and part-time working, whose track record and outputs may appear patchy or limited. Women, Black people and academics with disabilities are more likely to be on short-term contracts, increasing the need for discipline-hopping to secure employment, or to work part-time for health-related reasons or due to caring responsibilities. Although parental leave is usually an option for both parents, in the UK, women take the most, and are increasingly

taking more parental leave. Statistics from the last six years show that less than a third of eligible new fathers use their paternity leave in the UK (Taylor, 2019). The policy of shared parental leave is well-meaning, but in the context of a gig economy where fewer men take up the opportunity of parental leave, the gap between men and women taking time off for the birth of a child is widening (Petter, 2019). This leaves obvious gaps in CV, breaks up continuation of projects, networks, and makes it harder to stay updated on developments in the field. Inevitably, there are lulls in publishing papers when on maternity leave. (We note here that lulls occurring due to leave associated with pregnancy and birth can also occur in the CVs of trans men. Here, and in subsequent discussions of issues affecting parents – and most particularly mothers, we note a paucity of available literature on the experiences of trans men who undergo pregnancy, and a need for further understanding of the issues affecting this particularly marginalised group). Though explicit statements on CVs explaining any gaps can help, grants that emphasise track records in the selection criteria still place an expectation for track records and outputs to be competitive with those of men with no CV gaps. Confoundingly, a large scale study on economists in the US showed that men who took parental leave used the time to publish their research and raise their profile while women truly put their career on hold (Antecol et al., 2016). The effect of motherhood on women's academic careers does not stop at the end of maternity leave. Recent research shows that in general mothers suffer disproportionate earning penalties that can persist for up to 20 years after the birth of the first child (Kleven et al., 2019), and the motherhood penalty is a well-documented in academia (Mason et al., 2013) and in STEM fields (Cech & Blair-Loy, 2019). In households where one man and one woman hold parental responsibility, women still take on the larger share of caring for children with

a result that they are more likely to move to part-time work once they have a child and have shorter working days. Beyond motherhood, women are also more likely to care for elderly or disabled relatives and are twice as likely to have reduced working hours than other people who are unpaid carers. Many women are also more likely to be 'sandwich' carers, caring for both children and elderly parents (Carers UK, 2014) affecting further their ability to compete in an environment where overworking is the dominant model (Hoskins & Barker, 2020; Parizeau et al., 2016). Caring responsibilities also mean challenges in managing long absences and thus restriction in international travelling, widening the gap in international visibility and its recognition in successful track records. This is more acute for single parents, who are majority women.

While blind review appears as a potential approach to remove some of bias, research indicates that female applicants still receive significantly lower reviews (Kolev et al., 2019). In particular, the use of broad and narrow words employed by men and women respectively were identified as an important driver of the gender gap, indicating that communication style is a contributor to gender disparities in the evaluation of science and innovation (Kolev et al., 2019). The lived experience of women in STEM including experiencing imposter syndrome and self-perception of less successful track record (lesser international visibility and recognition of their accomplishment) can likely explain their tendency to write precise, topic specific language to demonstrate their expertise, however, it appears less attractive to reviewers who may be swayed by more hyperbolic, grandiose text even if it doesn't necessarily support a more valuable idea.

There are also several structural disadvantages in funding processes for women and for mothers. Short turnovers have become more frequent, notably on large calls associated with specific governmental funds such as the Global Challenges Research Fund (GCRF,

2020), the industrial challenges fund or the plastic research innovation fund. These short deadlines also favour those who can quickly call upon their professional network and, as discussed previously, in male-dominated environments, these people are more likely to be men. For instance, the EPSRC 2018 'Creative circular economy approaches to eliminate plastics waste', a two-step application, had a turnover between announcing the second round invitation and the deadline for full submission of less than four weeks – a total time between announcement and final deadline of nine weeks. The deadline for the both stages were during the school summer holidays in Scotland and England, which highlights another structural issue specifically for parents; many fixed deadlines are during or shortly after school holidays. Recent examples include the outline applications for the BBSRC 'Strategic Longer and Larger grants: Frontier bioscience' due on 30 July 2019 and even the 2018 EPSRC Inclusion Matters full proposals, aimed at proposal tackling inequalities in STEM academia, were due on the Tuesday after Easter Monday, again during the school holidays. Such deadlines are particularly stressful for those who are less able to prioritise grant applications over other commitments (Herbert et al., 2014). For these researchers, it means selecting themselves out for these calls or completing applications ahead of the deadlines, and therefore within a shorter timescale. Another example of additional pressure on mothers who carry the heavier load in caring responsibility through the funding process is the lack of flexibility around interview format, dates and location. Having to organise alternative childcare, particularly for single parents, and again especially if interviews are held during school holidays, is an undue stress in an already stressful situation. In 2016, EPSRC programme grant interviews were held on 2 September, which fell during the English school holiday; these are only held a few times a year and it would therefore be relatively simple to schedule them outside of

UK school holidays, even with the conflated issues of different term dates for the different nations. Additionally, UKRI's base in Swindon, where most interviews are held, is particularly inaccessible from most parts of the country; an overnight stay is required for most researchers travelling to Swindon and it will induce complicated childcare or other caring responsibilities implications for many female researchers.

Funding bodies are increasingly aware of these barriers and have gender equality policies (EPSRC, 2020), but these are not necessarily applied in the advertisement and selection process (van der Lee & Ellemers, 2015). For example, a recent grant application call from the UK Arts and Humanities Research Council (AHRC, 2020) explicitly stated: 'AHRC acknowledges with regret that not everyone in our academic community – for example those with caring responsibilities – will be equally placed to take part in it.' With a lack of evidence based decision making, transparency and accountability on how selection processes are designed and decisions are made (Adelaine et al., 2020), there is added potential for gender discrimination to take place – despite established policies. Two recent examples from UKRI illustrate these issues with accountability and transparency. First, the UKRI CEO responded to detailed questions about the distribution of research funding to individuals with protected characteristics from the House of Commons Science and Technology select committee of the UK parliament using aggregated data from all UKRI's constituent research councils (including non-scientific councils) instead of disaggregated data per council. This had the effect of obscuring STEM specific issues, where for instance women are much less represented than in other fields, and of preventing independent data analysis (TIGER in STEMM, 2019). We note however that further data were later released. Secondly, the transparency and accountability achieved in a recent funding process jointly organised by UKRI

and the National Institutes of Health (NIH) addressing Covid-19 and its disproportionate impact on BAME communities was called into question when it was revealed that (despite the specific equity focus of the funding call) no data monitoring of the protected characteristics of applicants or awardees had been collected and that one member of the assessment panel was a co-investigator on three of the six awards (Adelaine et al., 2020).

Conclusion

The quality of evidence on the barriers facing women in applying for funding is mixed, but is certainly sufficient to mandate both further investigation of the challenges described here, and the trialling of strategies to overcome them. When addressing the greater barriers experienced by women who experience intersectional discrimination, there is little information available in the literature about issues specific to funding applications, and UK funders do not currently release relevant data. Moreover, most funders do not even collect data which would allow researchers to assess the challenges facing LGBTQ+ women. With this paucity of data, it is extremely difficult to properly address the barriers faced by women in non-traditional gender roles (e.g. parents in same-sex partnerships) or gender minorities (e.g. non-binary people who may be wrongly perceived as women, or transgender men who may face challenges faced commonly by women). Collection of a broader spectrum of relevant data and measuring and releasing information relating to intersectionality will be an important starting point to assess the specific needs of intersectional groups.

The data which are available are sufficient to constitute an immediate call to action to both universities and funding bodies. Universities can address inequalities in funding processes by auditing their internal demand management procedures, and ensuring that the balance of workload for staff, such as service roles or other tasks

that currently prevent women from forming research-relevant networks, do not disproportionately disadvantage women. They can also facilitate ways in which women can work with role models and mentors who can support decision making, career planning, and developing skills. Funding bodies could audit universities' triage processes and the extent to which applications arising from a particular university are representative of the available body of applicants at that university. Where such audits highlight that marginalised researchers are under-represented as applicants, funders could mandate the development and implementation of action plans to redress the balance, as a condition for the award of further funding. It is imperative to avoid a situation where funders and universities each leave to the other the responsibility for ensuring that demand management does not unfairly disadvantage marginalised groups.

Funding bodies can further support women through evidence-based changes to competitive funding processes. They can introduce more calls with anonymised applications, focusing on the scientific case of the application without identified barriers such as track records. They can avoid the use of gender exclusive language in funding documents and consider carefully how language in application documents is evaluated. They can ensure that policies relevant to equality, diversity, and inclusion are applied to all funding

processes. Concerning support for mothers, and indeed for parents more broadly, funding bodies can also avoid short deadlines and deadlines close to school holidays.

The existence of substantial barriers to women's progression are clear. Women, and women facing intersectionality especially, are underrepresented in STEM careers, in many ways, for many reasons, and at every level. Although some societal issues are challenging to address, the policies and practices that directly and indirectly impact women's success in securing research funding can and should be addressed by UK universities, UKRI, and other funding bodies. Improving women's success rates, simply by implementing the practices we suggest above, might have substantial impact on career progression for women and other under-represented minorities in STEM, the wider UK research community, and the national economy. However, while this would help a wider group of people fit within a model originally designed by one demographic for themselves, a more effective approach might be to fully redesign the model to inclusively fit all demographics and to provide from its inception equal chances for everyone to succeed and thrive in STEM research.

Authors

Julie M. Jebesen, Cathy Abbott, Rachel Oliver, Erinma Ochu, Izzy Jayasinghe & Caroline Gauchotte-Lindsay

References

- Adelaine, A., Kalinga, C., Asani, F. et al. (2020). Knowledge is power – an open letter to UKRI. *Research Professional News*. Retrieved from www.researchprofessionalnews.com/rr-news-uk-views-of-the-uk-2020-8-knowledge-is-power-an-open-letter-to-ukri/
- Advance HE. (2018). *Equality in higher education: Staff statistical report 2018*. Retrieved from www.ecu.ac.uk/publications/equality-higher-education-statistical-report-2018/
- Altinas, E. & Sullivan, O. (2016). Fifty years of change updated: Cross-national gender coverage convergence in housework. *Demographic Research*, 35(16), 455–470.
- Antecol, H., Bedard, K. & Stearns, J. (2016). Equal but inequitable: Who benefits from the gender-neutral tenure clock stopping policies? *American Economic Review*, 108(9), 2420–2441.
- Arts and Humanities Research Council (2020). *Research and innovation ideas to address Covid-19*. Retrieved from <https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/research-and-innovation-ideas-to-address-covid-19/>
- Bacon, L. (2015). *This mathematical formula shows that all-male panels are sexist*. Retrieved from <https://qz.com/524694/524694>

- Blickenstaff, J.C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education*, 17(4), 369–386.
- Bol, T., de Vaan, M. & van de Rijt, A. (2018). The Matthew effect in science funding. *PNAS*, 115(19), 4887–4890.
- Boring, A. (2017). Gender biases in student evaluations of teaching. *Journal of Public Economics*, 145, 27–41.
- Brown, N. & Leigh, J., (2018). Ableism in academia: Where are the disabled and ill academics? *Disability and Society*, 33(6), 985–989.
- Casadevall, A. & Handelsman, J. (2014). The Presence of Female Conveners Correlates with a Higher Proportion of Female Speakers at Scientific Symposia. *mBio*, 5(1), 1–4.
- Carers UK. (2014). *Caring and family finances inquiry*. UK report. Retrieved from www.carersuk.org/for-professionals/policy/policy-library/caring-family-finances-inquiry
- CaSE Report (2014). *Improving diversity in STEM*. London: Kings College London.
- Cech, E.A. & Blair-Loy, M. (2019). The changing career trajectories of new parents in STEM. *Proceedings of the National Academy of Sciences*, 116(10), 4182–4187.
- Chemistry & Industry. (2011). Science is in danger of becoming a treadmill. *Chemistry & Industry*, 2. Retrieved from www.soci.org/Chemistry-and-Industry/CnI-Data/2011/2/Science-is-in-danger-of-becoming-a-treadmill
- Clayton, A. O'Brien, D.Z., Piscopo, J.M. (2018). All male panels? Representation and democratic legitimacy. *American Journal of Political Science*, 63(1), 113–119.
- Crenshaw, K. (1989). Demarginalising the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum*, 189, 139–167.
- Eagly, A.H. & Carli, L.L. (2007). *Through the labyrinth: The truth about how women become leaders*. USA: Harvard Business Press
- Eaton, A.A., Saunders, J.F., Jacobson, R.K., & West, K. (2019). How gender and race stereotypes impact the advancement of scholars in STEM: Professors' biased evaluations of physics and biology post-doctoral candidates. *Sex Roles*, 1–15.
- Eloy, J.A., Svider, P.F., Kovalerchik, O. et al. (2013). Gender differences in successful NIH grant funding in otolaryngology. *Otolaryngology – Head and Neck Surgery*, 149(1), 77–83.
- Engineering and Physical Sciences Research Council. (2019). A list of EPSRC Programme Grants. Retrieved from <https://epsrc.ukri.org/funding/applicationprocess/routes/capacity/programme/fundedgrants/>
- Engineering and Physical Sciences Research Council. (2020). *Equality Impact Assessment*. Retrieved from <https://epsrc.ukri.org/funding/edi-at-epsrc/equality-impact-assessment/>
- Eriksson, E., Pargman, D., Robert, M. & Laaksolahti, J. (2020). *On the Necessity of flying and of not flying: Exploring how computer scientists reason about academic travel*. In Proceedings of the 7th International Conference on ICT for Sustainability, 18–26.
- Forret, M.L. & Dougherty, T.W. (2004). Networking behaviours and career outcomes: Differences for men and women? *Journal of Organizational Behaviour*, 25, 419–437.
- Fox, M.F. (2010). Women and men faculty in academic science and engineering: Social-organisational indicators and implications. *American Behavioural Scientist*, 53(7), 997–1012.
- Fox, M.F., Realff, M.L., Roldan Rueda, D., & Morn, J. (2017). International research collaboration among women engineers: frequency and perceived barriers, by regions. *The Journal of Technology Transfer*, 42(6), 1292–1306
- Gibney, E. (2017, April 13). Teaching load could put female scientists at a career disadvantage. *Nature News*. Retrieved from www.nature.com/news/teaching-load-could-put-female-scientists-at-career-disadvantage-1.21839
- Gibney, E. (2019, June 27). Discrimination drives LGBT+ scientists to think about quitting. *Nature News*. Retrieved from www.nature.com/articles/d41586-019-02013-9
- Global Challenges Research Fund (2020). *Global Challenges Research Fund*. Retrieved from www.ukri.org/research/global-challenges-research-fund/
- Guarino, C.M. & Borden, V.M. (2017). Faculty service loads and gender: Are women taking care of the academic family? *Research in Higher Education*, 58(6), 672–694.
- Gustafson, P. (2006). Work-related travel, gender and family obligations. *Work, employment and society*, 20(3), 515–530.
- Herbert, D.L., Coveney, J., Clarke, P. et al. (2014). The impact of funding deadlines on personal workloads, stress and family relationships: A qualitative study of Australian researchers. *BMJ Open*, 4(3), 1–8.
- Hoskins, K. & Barker, B. (2020). *STEM, social mobility and equality: Avenues for widening access*. Switzerland: Springer Nature
- Howe-Walsh, L. & Turnbull, S. (2016). Barriers to women leaders in academia: Tales from science and technology. *Studies in Higher Education*, 41(3), 415–28.
- Hyde, J. (2005). The gender similarities hypothesis. *American Psychologist*, 60(6), 581–592.

- Hyde, J. (2016). Sex and cognition: Gender and cognitive functions. *Current Opinion in Neurobiology*, 38, 53–56.
- Hyde, T. (2017, April 3). No women in the room. Are male-dominated tenure committees olding women back in academia? *American Economic Association*. Retrieved from www.aeaweb.org/research/no-women-in-the-room
- Institute of Physics, Royal Astronomical Society, & Royal Society of Chemistry. (2019). *Exploring the workplace for LGBT+ physical scientists*. Retrieved from www.rsc.org/globalassets/04-campaigning-outreach/campaigning/lgbt-report/lgbt-report_web.pdf
- Jones, C. (2006). Falling between the cracks: What diversity means for black women in higher education. *Policy Futures in Education*, 4(2), 145–159.
- Kandola, B. & Kandola, J. (2013). *The invention of difference: The story of gender bias at work*. Oxford: Pearn Kandola Publishing
- Kleven, H., Landais, C., Posch, J. et al. (2019). Child Penalties across countries: Evidence and explanations. In *AEA Papers and proceedings* (109), 122–126.
- Knobloch-Westerwick, S., Glynn, C.J., & Huge, M. (2013). The Mathilda effect in science communication: An experiment on gender bias publication quality perceptions and collaboration interest. *Science Communication*, 35(5), 603–625.
- Kolev, J., Fuentes-Medel, Y. & Murray, F. (2019). *Is blinded review enough? How gendered outcomes arise even under anonymous evaluation* (No. w25759). National Bureau of Economic Research.
- Kumar, S. (2014). Effect of gender on collaborative associations of researchers in Malaysia. *The Electronic Library*, 34(1), 74–82.
- Larivière V., Ni, C., Gingras, Y. et al. (2013). Bibliometrics: Global gender disparities in science. *Nature News*, 504(7479), 211.
- Ley, T.J. & Hamilton, B.H. (2005). The gender gap in NIH grant applications. *Science*, 322, 1472–1474.
- Levinson, W., Kaufman, K., Clark, B. & Tolle, S.W. (1991). Mentors and role models for women in academic medicine. *Western Journal of Medicine*, 154(4), 423–426.
- Lopez, S.A., Svider, P.F., Misra, P. et al. (2014). Gender differences in promotion and scholarly impact: An analysis of 1460 academic Ophthalmologists. *Journal of Surgical Education*, 71(6), 851–859.
- Maldonado, H. & Draeger, J. (2017). Identifying, understanding, and responding to sexism in academia. In K. Cole & H. Hassel (Eds). *Surviving sexism in academia: Strategies for feminist leadership*. New York: Taylor and Francis
- Mason, M.A., Wolfinger, N.H. & Goulden, M. (2013). *Do babies matter?: Gender and family in the ivory tower*. London: Rutgers University Press.
- McAllister, D., Juillerat, J. & Hunter, J. (2015). *Towards better understanding of issues affecting grant applications and success rates by female academics*. Retrieved from <https://bbsrc.ukri.org/documents/1511-understanding-app-rates-by-female-academics/>
- Merton, R.K. (1968). The Matthew Effect in science. *Science*, 159, 56-63.
- Misra, J., Lundquist, J. H. & Templer, A. (2012). Gender, work time, and care responsibilities among faculty. *Sociological Forum*, 27(2), 300–323.
- Mitchell, S.M. & Hesli, V.L. (2013). Women don't ask? Women don't say no? Bargaining and service in the political science profession. *PS: Political Science & Politics*, 46(2), 355–369.
- Morehouse, C., Volkova, A. & Fierascu, S. (2018). *An end to manels: Closing the gender gap at Europe's top policy events*. Retrieved from www.opensocietyfoundations.org/publications/end-manels-closing-gender-gap
- Moss-Racussin, C.A., Dovidio, J.F., Brescoll, V.L. et al. (2012) Science faculty's subtle gender biases favour male students. *PNAS*, 109(41), 16474–16479.
- Medical Research Council (2019). *Success Rate 2017/2018*. Retrieved from <https://mrc.ukri.org/research/funded-research/success-rates/>
- Office of National Statistics. (2016, November 10). *Women shoulder the responsibility of 'unpaid work'*. Retrieved from www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/articles/womenshouldtheresponsibilityofunpaidwork/2016-11-10
- Parizeau, K., Shillington, L., Hawkins, R. et al. (2016). Breaking the silence: A feminist call to action. *The Canadian Geographer*, 60(20), 192–204.
- Peel, J.K., Schlachta, C.M. & Allkhamesi, N.A. (2018). A systematic review of the factors' affecting choice of surgery as a career. *Canadian Journal of Surgery*, 61(1), 58–67.
- Pepin, J.R., Sayer, L.C. & Casper, L.M. (2018). Marital status and mothers' time use: Childcare, housework, leisure, and sleep. *Demography*, 55(1), 107–133.
- Petter, O. (2019, July 8). Fewer than a third of new fathers take paternity leave, research suggests. Independent. Retrieved from www.independent.co.uk/life-style/health-and-families/paternity-leave-new-fathers-less-third-not-taking-a8992086.html
- Phillips, K.W., Medin, D., Lee, C.D. et al. (2014). How diversity works. *Scientific American*, 311(4), 42–47.
- Rollock, N. (2019). *Staying power: The career experiences and strategies of UK Black female professors*. University and College Union.

- Royal Society (2014). *A Picture of the UK scientific workforce*. Diversity data analysis for the Royal Society. Summary report. https://royalsociety.org/~media/Royal_Society_Content/policy/projects/leading-way-diversity/picture-uk-scientific-workforce/070314-diversity-report.pdf
- Saxena, A. (2014). Workforce diversity: A key to improve productivity. *Procedia Economics and Finance*, 11, 76–85.
- Santos, G. & Dang Van Phu, S. (2019). Gender and academic rank in the UK. *Sustainability*, 11(11), 3171.
- Shen, H. (2013) Inequality quantified: Mind the gender gap. *Nature*, 495, 22–24.
- Stockfelt, S. (2018). We the minority-of-minorities: A narrative inquiry of black female academics in the United Kingdom. *British Journal of Sociological of Education*, 39(7), 1012–1029.
- Storme, T., Beaverstock, J.V., Derudder, B. et al. (2013). How to cope with mobility expectations in academia: Individual travel strategies of tenured academics at Ghent University, Flanders. *Research in Transportation Business & Management*, 9, 12–20.
- Storme, T., Faulconbridge, J.R., Beaverstock, J.V. et al. (2016). Mobility and professional networks in academia: An exploration of the obligations of presence. *Mobilities*, 12(3), 405–42.
- Taylor, J. (2019). *Less than a third of eligible men take paternity leave*. Retrieved from www.emwllp.com/latest/less-than-a-third-of-men-take-paternity-leave/
- TIGER in STEMM. (2019). Underwhelming UKRI analysis masks major issues related equality, diversity and inclusion within the UK research sector. Retrieved from www.tigerinstemm.org/news/pr_ukri_20191105
- Thanacoody, P.R., Bartram, T., Barker & Jacobs, K. (2006). Career progression among female academics. A comparative study of Australia and Mauritius. *Women in Management Review*, 21(7), 536–553.
- Tefera, A.A., Powers, J.M. & Fischman, G.E. (2018). Intersectionality in education: A conceptual aspiration and research imperative. *Review of Research in Education*, 41(1), 7–17.
- UK Research and Innovation. (n.d). UKRI Future Leaders Fellowships assessment criteria. Retrieved from www.ukri.org/files/funding/flf-assessment-criteria/
- UK Research and Innovation. (2018). *Research Councils' Diversity Data (April 2018)*. Retrieved from www.ukri.org/files/rcuk-diversity-headline-narratives-april2017-pdf
- UK Research and Innovation. (2020). *Diversity results for UKRI funding data 2014–2015 to 2018–2019*. Retrieved from www.ukri.org/files/about/ukri-diversity-report/
- Van der Lee, R. & Ellemers, N. (2015). Gender contributes to personal research funding success in The Netherlands. *Proceedings of the National Academy of Sciences*, 112(40), 12349–12355.
- Vaughn, A.R., Taasobshirazi, G. & Johnson, M.L. (2019). Impostor phenomenon and motivation: Women in higher education. *Studies in Higher Education*, 45(4), 780–795.
- Vokić, N.S., Obadić, A., & Ćorić, D.S. (2019). The consequences of gender segregation in the contemporary work environment: Barriers to women's employment, development, and advancement. *Gender Equality in the Workplace*, 61–73.
- Waisbren, S.E., Bowles, H., Hasan, T. et al. (2008). Gender differences in research grant applications and funding outcomes for medical school faculty. *Journal of Women's Health*, 17(2), 207–214.
- Weale, S. & Barr, Caelainn. (2018, August 10). Female scientists urge research grants reform to tackle gender bias. *The Guardian*. Retrieved from www.theguardian.com/education/2018/aug/10/female-scientists-urge-research-grants-reform-tackle-gender-bias
- Wellcome (2018). *Wellcome grants awarded 2015–2018*. Retrieved from <https://wellcome.ac.uk/funding/people-and-projects/grant-funding-data>
- Wellcome (2020). *What researchers think about the culture they work in*. Retrieved from <https://wellcome.ac.uk/sites/default/files/what-researchers-think-about-the-culture-they-work-in.pdf>
- Witteman, H.A., Hendricks, M., Straus, S. & Tannenbaum, C. (2019). Are gender gaps due to evaluations of the applicant or the science? A natural experiment at a national funding agency. *The Lancet*, 393(10171), 531–540.
- Women and Work Commission (2009). *Shaping a fairer future: Women and Work Commission three years on*. 1–56. Retrieved from https://webarchive.nationalarchives.gov.uk/20100211010917/http://www.equalities.gov.uk/pdf/297158_WWC_Report_acc.pdf
- Wright, C., Thompson, S. & Channer, Y. (2007). Out of place: Black women academics in British universities. *Women's History Review*, 16, 145–162.
- Yong, E. (2017, December 18). Women are invited to give fewer talks than men at top US universities. *The Atlantic*. Retrieved from www.theatlantic.com/science/archive/2017/12/women-are-invited-to-give-fewer-talks-than-men-at-top-us-universities/548657/
- Zippel, K. (2018). Gendered images of international research collaboration. *Gender, Work and Organization*, 26(12), 1794–1805.