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ESSAY

The impact of research culture on mental health & diversity in STEM

Juanita C. Limas[b], Linda C. Corcoran[c], Alexander N. Baker[d], Ana E. Cartaya[e], and Zoë J. Ayres[a]

[a] Zoë Ayres+, Senior Scientist & Mental Health Advocate
Birmingham, United Kingdom
E-mail: zjayres@gmail.com

[b] Juanita C. Limas+, PhD candidate
Department of Pharmacology
University of North Carolina at Chapel Hill
Chapel Hill, NC USA

[c] Linda C. Corcoran+
Tipperary, Ireland

[d] Alexander N. Baker+, PhD candidate
Department of Chemistry
University of Warwick
Coventry, United Kingdom

[e] Ana E. Cartaya, PhD candidate
Department of Surgery
Center for Nanotechnology in Drug Delivery
Department of Pharmacology
McAllister Heart Institute
University of North Carolina at Chapel Hill
Chapel Hill, NC USA

[+} These authors contributed equally to this work.

Abstract: The onset of COVID-19, coupled with the finer lens placed on systemic racial disparities within our society, has resulted in increased discussions around mental health. Despite this, mental health struggles in research are still often viewed as individual issues and not the result of a larger dysfunctional research culture. Mental health interventions in the science, technology, engineering, and mathematics (STEM) academic community often focus on what individuals can do to improve their mental health instead of focusing on improving the research environment. In this paper, we present four aspects of research that may heavily impact mental health based on our experiences as research scientists: bullying and harassment; precarity of contracts; diversity, inclusion, and accessibility; and the competitive research landscape. Based on these aspects, we propose systemic changes that institutions must adopt to ensure their research culture is supportive and allows everyone to thrive.

Why mental health matters

We can all picture the pop-culture scientist: working late into the night, more focused on 'thinking than feeling.'[1] This is a damaging stereotype**,** inadvertently (and incorrectly) suggesting that as scientists our work should always come first, and that our mental and physical health should take a back seat. And yet scientists are humans, and research cannot be conducted without them. Humans have biases, causes they are passionate about, worries, and of course we all have mental health. It therefore follows that looking after the scientists behind the science is essential to build a positive, productive research environment.[2]

The ability to maintain good mental health intersects with a range of equality, diversity and inclusion (EDI) initiatives. For example, it has been shown that diverse teams lead to better science,[3,4] and yet individuals that provide mental health support within institutions are more likely to be experiencing mental illness themselves, adding additional strain. This highlights the need to provide assistance and training for those providing support.[5] If an individual's mental health is not a priority, they may ultimately end up leaving their institution, resulting in a loss of diversity *and* talent. This is supported by a recent Nature survey of postdoctoral researchers, where 51% had considered leaving science due to anxiety, depression, or similar issues related to their work.[6] Furthermore, the COVID-19 pandemic has only exacerbated this already fraught researcher mental health crisis, with 78% of research staff showing moderate to severe signs of mental health distress due to the strain added onto this already highly pressured working environment.[7] When the competitive nature of scientific discovery and the scarcity of research funding is added to this, speaking out about mental health can feel (and be) detrimental to one's career advancement. Evidentially, institutions need to do more to support our researchers.

This paper has several aims. The first, to highlight the role that research culture plays in Science, Technology, Engineering and Mathematics (STEM) academic researcher mental health, focusing on four key areas we have routinely come across in our own scientific careers: bullying and harassment; the precarity of research contracts; diversity and inclusion; and the competitive research landscape. We believe this is a much-needed conversation as there is a tendency for university wellbeing support to focus only on what the individual can do to improve their own mental health, rather than acknowledge institutional factors at play. Further, we wish to highlight some key recommendations that contribute towards a research culture where scientists can thrive. Finally, this is a **call to action**, to encourage institutions to move beyond performative action when it comes to mental health support towards real, tangible change.

This paper is in no way comprehensive as the underlying STEM culture (including chemistry) is vast – we simply cannot cover it all – but we hope that by highlighting key challenges, as well as the need for further discussion, more detailed data collection, and the clear need for change, that together we can drive for a more inclusive, thriving chemistry community.

Bullying and Harassment

"Some people think industry is where the harassment happens. But in industry, creeps get fired. In academia, they get funding."
—"Elizabeth," colleague of a sexual harassment survivor"[8]

Bullying and harassment often contributes to long-term health (both physical and mental) issues and impact performance within the workplace,[9] and can take many forms in the scientific research environment, from someone openly shouting at and/or shaming staff and students publicly, to more subtle microaggressions.[10] Other bullying behaviours include: threatening to withhold reference letters and/or funding; not renewing visa applications; omitting someone from the author list of a paper; not giving credit for intellectual property; and exclusion from events.[11] Power abuse, particularly from PhD supervisors, can also involve denying reasonable requests for vacation time and delaying PhD submission to retain expertise, which is often not in the best interests of the PhD student. It is important to note that scientists who are from historically excluded groups such as People of Colour (PoC),[12] disabled individuals,[13] members of the LGBT+ community,[14] and women may be subject to increased levels of bullying and harassment, aiding "the leaky pipeline" and impacting retention of talent.[15]

Bullying and harassment is rife in the sciences. 74% of postdoctoral staff report observing bullying behaviour or abuse of power at their institution,[16] with 60% of researchers attributing workplace bullying behaviour to their manager/ supervisor.[17] Further, in a recent CACTUS mental health survey, a high number of researchers (48%) stated that their institution does not have a

comprehensive bullying and harassment policy, leaving them with few options even if they did want to report an incident.[18]

The "Me Too" Movement in recent years has enabled increasing conversations around sexual harassment in academia and even resulted in a STEM specific social media hashtag #STEMToo for individuals to share their stories and shine light on power imbalances within academia. Unsurprisingly, it has been found that sexual harassment negatively impacts motivation to stay in STEM and career aspirations.[19] A study on undergraduate female physicists found that three quarters of those surveyed (n=455) had experienced at least one type of sexual harassment.[20] A high incidence of sexual harassment continues as women move into senior positions, with the 2018 "Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine by the National Academies Press, indicating that greater than 50 percent of women faculty and staff encounter sexually harassing conduct in academia.[21] Fieldwork, which is essential for some scientific endeavours, such as the geosciences and archaeology among many others, has also been found to be riddled with sexual harassment concerns, with 64% of respondents (78% women) being exposed to some form of sexual harassment during fieldwork, and 22% being victims of sexual assault.[22] It is evident that STEM is often not a safe place for individuals to work, and that this clearly can impact mental health. Reporting rates are also low, with only 6% of sexual harassment survivors reporting incidents,[8] and students from life sciences and physical sciences 1.7 times less likely to report an incident than students in other disciplines.[23]

More recently, professional bodies and funding bodies are starting to acknowledge the need to improve bullying and harassment support in academia. The Royal Society of Chemistry (RSC) in the United Kingdom has created a Bullying and Harassment support hotline[24] as well as their "Breaking the Barriers" report[15] and "Exploring the workplace for LGBT+ physical scientists"[14] report (in collaboration with the Institute of Physics and Royal Astronomical Society) which revealed problems with bullying, accounts of intimidation and victimisation either holding back scientists' careers or forcing them to change jobs". In 2021, it was also announced that the National Institutes of Health (NIH) withdrew funding from 75 Principal Investigators due to misconduct.[25] It is clear change is happening – though many initiatives tackle symptoms of bullying and harassment rather than the cause. Momentum must be maintained, with not only clear reporting routes made available, but also consequences for those that are found guilty of misconduct. This was reiterated by the RSC when discussing bullying and harassment within chemistry: "culture change will take a joined-up effort from across our whole community".[26]

Precarity of Contracts

"I am tired, depressed, and struggle to cope. I worry constantly what will happen if I am sick or don't manage to find enough work."
— University staff member[27]

Job security has been found to be a primary source of job stress in Higher Education, according to the 2018 RAND Europe report,[28] with a recent Wellcome Trust Research Culture study, emphasising that a key challenge facing early career researchers (and academia) was short term, insecure contracts leading to mental health concerns.[29]

To put precarity in perspective, in the UK, a recent University and College Union (UCU) survey[27] found 70% of researchers in higher education were on fixed-term contracts and that 71% of the 3,802 respondents "believed their mental health had been damaged by working on insecure contracts". Despite these issues surrounding casualised contracts in academia and their wide discussion in the literature and media; precarious/casualised workers remain largely invisible in university policies and statistics.[30]

However, there has been some attempt in the chemical sciences to discuss precarity. For example, following the RAND report, mental health workshops were held by the Royal Society of Chemistry (RSC) to gain a community perspective on the data presented. In these sessions it was impressed upon the RSC by attendees that the issue of short-term contracts should be "tackled".[31] Precarity is also an area also noted by the RSC as a factor impacting the retention and progression of women in Chemistry.[15]

Further, a recent Organisation for Economic Cooperation and Development (OECD) report discussing precarity in Science, Technology and Industry explicitly explored the effects of precarity on postdoctoral staff.[32] The report identified four effects of precarity; decreased well-being of researchers, decreased attractiveness of the research career, decreased quality of science and negative differences by gender and other demographic factors. Interestingly the report cites two other reports, one from Wellcome carried out before the COVID-19 pandemic and the other from the Australia Academy of Science during the pandemic.[17,33] While both underline the impact precarity has on mental health, the Australian report comments that the impact of precarity has increased during COVID-19, especially for women, and that this is likely to further impact wellbeing. Similar trends were covered in a series of articles in Nature discussing postdoctoral researchers.[16, 34-35]

Progress has been made by some European countries to limit the use of casual contracts; notably the United Kingdom that allows for the switching of fixed-term employment contracts to permanent contracts after a defined period, and the European Union that has pushed for decreasing precarity within its member states. However, there are always nuances and limitations that must be considered, for example the differences between workers and employees in the UK; this difference can (and is) used to exclude workers from the benefits and protections employees receive. Therefore, while legislative progress has been made (in some countries) there is still much work to do in universities that continue to rely heavily on casualised labour for the core duties of the University - namely teaching and research.

In summary, while it is clear that precarious contracts impact mental wellbeing in the Sciences and that the impact of precarity falls unfairly on women and other historically excluded groups - more research is needed to understand the problem in Chemistry. Although, extrapolating the effects of casualisation into Chemistry would suggest casualisation or precarity is a serious threat to mental wellbeing. The larger question then is what does the academic community, from funders to faculty, plan to do about it?

Diversity, Inclusion, and Accessibility

"I have never asked for special treatment. I did not seek it here. All I asked was to be judged by my credentials and treated fairly and equally."
— Nikole Hannah-Jones"[36]

Science and innovation that truly benefits society is dependent on people with unique perspectives bringing new ideas to the table to solve the challenges of today and of tomorrow.[37] If diversity is not present, some of these scientific challenges may not even be realised. However, science is still far from equitable. A significant gap still exists that affects historically marginalized groups more heavily. This includes women,[38-39] disabled people,[40] neurodivergent individuals, racial/ethnic minorities,[41-42] those from poorer socioeconomic backgrounds,[43] and the LGBTQIA+ community.[14] For example, data released by the Royal Society in 2021, shows that of STEM academic staff in the United Kingdom under the age of 34 (thus the next generation of academics) only 1.8% are Black.[44] The so-called 'leaky pipeline' for women in STEM is also evident, with chemistry undergraduate cohorts at~44% women, dropping to 9% at professorial level.[15]

There is a huge range of factors that play into the retention of a diverse STEM workforce. We cannot explore them all in this article as they are vast, but we postulate many add to 'minority stress' and can impact the mental health of these historically marginalized groups.[45-47] For example, these individuals may be subject to intense bullying and harassment, as well as microaggressions in the workplace.[48] Further, being a first generation academic can lead to significant disadvantage – those that have parents who have already been in academia are more likely to get tenure.[49] It has also been shown that underrepresented students innovate at a higher rate than majority students, but are less likely to be recognized for their contributions, termed the "Diversity-Innovation Paradox in Science", likely adding additional strain on these individuals and impacting mental health.[50] Accessibility and ableism can also dramatically affect disabled scientists, and lack of visibility can affect LGBTQIA+ individuals, both discussed in detail in previous Science Voices articles we recommend reading, by Sarju and Unsay, respectively.[51-52]

Fortunately, diversity is becoming a larger focus for many academic institutions in order to address the inequity that exists, and things *are* improving, despite change being slow. However, the problem with many diversity and inclusion initiatives is that they routinely place the responsibility on the historically marginalized groups to conform to the current (often exclusionary) system. For example, often the perceived 'solution' is to simply bring more of these underrepresented groups into science through various recruiting efforts and diversity programs, yet not addressing the working environment itself which may lead to psychological distress.[53] Thankfully some effective diversity and inclusion initiatives do exist, that ensure by-in from all individuals including senior leadership.

We must also consider the role that science's competitive, sometimes fierce nature can have on minoritized groups, particularly when individuals may already feel "othered" and alone, with few colleagues/mentors around them who truly understand what they are going through due to lack of representation.[54] Mental health being less talked about in some cultures may also compound feelings of isolation.[55]

Further, we propose that mental illness is a topic that must be considered at the core of DEI work, particularly when it moves beyond short-term conditions into chronic illness and towards disability.[56] To date the intersection between disability and mental illness (also termed mental disability) is largely unexplored in academic mental health literature or in DEI work. One of the few studies on mental disability in faculty found that many were not aware that mental illness qualified them for disability accommodations and even fewer (<13%) utilised them. [57] In addition, that same study found that respondents found their supervisors (or department chairs) and on-campus mental health services were the least useful available supports. It is apparent that more work is needed in this area, both in terms of research and making sure resources are clearly signposted, as well as ensuring they are fit for purpose.

It is incredibly important that we reflect on the research environment and workplace culture at our institutions and consider the impact it can have on historically marginalized groups. These kinds of changes are not just better for science, but also because everyone deserves to work in a safe and inclusive space.

The competitive landscape

"Not only can the academic environment be confusing as to how and why people compete but also many participants are also under the impression that the often-ignored negative side effects counterbalance the positive effects which competition might bring about." [58]

The competitive research environment affects individuals (and subsequently mental health) all the way through the academic ladder, from PhD students competing with peers within their own research group for the attention of their PhD supervisor, to Principal Investigators competing with each other on an (inter)national scale for limited funding. It is deeply ingrained in the academic system that competition[59] helps further scientific discovery,[60] with the academic career system utilised by many countries and universities even being named the "competition model".[61] However this "healthy competition" can easily turn into dysfunctional hyper-competition, and this is the reality many face in academia.[58, 62] Hyper-competition negatively affects relationships within a department by reducing the sense of community[63] and collaboration.[62] Further, graduate students are less likely to feel comfortable disclosing mental health struggles to an advisor in a group where there is a culture of competition.[64] Yet hyper-competition doesn't manifest on its own - rather it is present with and spurred on by many other negative aspects of research culture[65] such as the "publish or perish" attitudes[66], the high turnover of students and ECRs[62] , and expectations of long working hours.[29]

The long work hours and work-life conflict have a detrimental impact on diversity in STEM. The RSC report "Breaking the Barriers" found that over 80% of female chemists thought that the long working hours in academia strongly or very strongly impacts on the retention and progression of women in UK academic roles in the chemical sciences.[15] Further, while working hours have not been found to vary significantly by gender, women are consistently the most impacted by the consequences arising from them (work-life conflict),[67-68] and this only intensifies for women with children.[69-70] Acker and Armenti found that women faculty with children tend to sleep less to cope with this work-life conflict and the need to "keep up" with their roles and colleagues.[69] Little research has been conducted into how parenthood impacts work-life conflict for those with intersectional identities, yet a qualitative study by Kachchauf et al. highlights that this impact is compounded for BIPOC women with children or a caregiver role.[71] Recent events (COVID-19), has only worsened this work-life conflict for many and can especially be seen in the disparity of publications[72-73] and research "productivity"[74] for men and women. Also fuelled by hyper-competition is the attrition of disabled individuals from all levels of academia, as the dynamic and varied nature of disability does not align well with long-working hours and publish or perish.[51, 75]

In academia working overtime can often be regarded as the only way to show passion and commitment to research[76-77] and is nearly an expectation set by senior faculty.[29] Worryingly, a recent survey by CACTUS found that 31% of researchers (all career levels) reported typically working more than 50 hours a week,[18] even though the EU Directive (2003/88/EC)[78] states a maximum of 48 hours average work week for both physical and mental health reasons.

Ultimately, work-life conflict and workload (or overload), in particular, has been found to be the strongest predictor of psychological distress (e.g., burnout, depression, and anxiety) for both PhD students,[1, 79] and academics,[70, 80] and can no longer be ignored.

Further, a sense of community and "belonging" is key for researcher well-being as found in the 2021 RSC report "A Sense of Belonging in the Chemical Sciences",[81] improving mental health and self-confidence, as well as producing better science. This highlights the importance of a collaborative working environment.

Key Recommendations

While it is clear that managing mental health in STEM is a complex and multi-faceted problem, there are clear areas in which institutions can proactively work towards improving the mental health of their researchers. These are a useful starting point for institutions, course leaders, and students trying to drive change through grass-roots efforts:

- **Lead with data:** Asking your staff/students about their well-being and what is impacting them at both an individual and

institutional level is essential to make change as well as demonstrating improvements.

- **Avoid minimising experiences over small data sets**: When a minority group is affected by the research culture it can be all too easy to focus on "bigger issues" due to a small percentage of individuals being affected, and/or only having qualitative evidence of concerns, yet it is these individuals who are essential to retain diversity, so the environmental factors affecting their experience must be taken seriously.
- **Train both Principal Investigators and students:**[82] Mental health is complex - not having the tools to support yourself and those around you makes it even harder, thus mental health training is essential. It is also important to note that providing training does not make individuals mental health experts, and therefore investment must be made in specialist mental health experts.
- **Diversify your diversity initiatives:** Make sure that ownership of diversity initiatives is not placed solely on historically excluded and marginalised groups - buy-in from all levels is needed to enact change.
- **Ensure visible reporting routes:** There should be clear, formal reporting routes for bullying and harassment, and allegations should be both taken seriously and acted upon.
- **Encourage the conversation:** Speaking out about mental health can be tough, and individuals can feel isolated. This can be addressed by opening up the conversation in open forum discussions within the scientific community.
- **Put diversity and inclusion at the core:** Diversity must be factored and weighted into all promotions/tenure decisions as well as for funding decisions.
- **Provide mentorship and sponsorship**: Support and guidance to navigate precarity and ensure swift onboarding is needed, as well as sponsorship throughout careers. For example putting individuals forward for promotion.
- **Invest in people:** See people as long-term investments, not just short-term commodities - phase out precarious and casual contracts. Ring-fence funding for longer term contracts and provide crisis funding.
- **Reward collaboration over competition:** Collegiality and collaboration should be positioned at the core of research environments. This includes reconsidering the metrics that are used to measure success within academia, working towards acknowledging and rewarding EDI work and collaborative research, as well as building a sense of community and belonging.
- **Highlight existing resources:** Make sure that resources that are already available are frequently signposted.
- **Promote life-work balance:** Enable flexible working, with the understanding that researchers are more than their science.

Conclusions

In conclusion, the picture of the pop-culture scientist working late into the night and "thinking not feeling", is perhaps an unhealthy and counterproductive one. It disguises, detracts, and distracts from the ongoing mental health and diversity crises in academia. Crises are fuelled by bullying and harassment, precarious contracts, a lack of inclusion, and an overly competitive research landscape.

These causal factors can only be addressed through concerted efforts across all levels of academia from individuals (particularly those in power) to the institution. Furthermore, because these are interconnected issues, for example members from underrepresented groups are more likely to be bullied and on precarious contracts; one issue cannot be fixed in isolation, they must all be considered holistically as part of redesigning the research environment and culture to enable everyone to thrive.

There is also a still a distinct lack of data on the experiences of researchers, particularly around suicidal ideation, as discussed by Satinsky et al,[83] who highlight the need for university programs to 'systemically monitor and promote the mental health of Ph.D. students. To do this, first we must acknowledge that research mental health needs both urgent focus and urgent action.

The question then is what does the STEM academic community, from funder to faculty, plan to do? Will we do something, or will we continue to baulk as bystanders? To you, we ask - How many more talented scientists are we willing to sacrifice in the name of scientific "progress"?

Disclaimer

Science Voices are opinion articles written by scientists around the world and the views and opinions expressed in this article are those of the authors and not necessarily those of Wiley-VCH.

Juanita C. Limas (she/her/ella) is a PhD candidate and Howard Hughes Medical Institute (HHMI) Gilliam Fellow at the University of North Carolina at Chapel Hill. Her research focuses on origin licensing in the cell cycle and the role of cyclin E at the G1-S transition. She is also invested in empowering scientists from historically marginalized groups and first-generation students to pursue PhDs in STEM.

Linda C. Corcoran (she/they) is a food/sensory scientist with a Bachelors in Food Science. She is currently undertaking a research Masters of Food and Nutritional sciences. In their spare time, Linda is an avid mental and disability advocate, who volunteers for with several community groups and non-profit organisations. Linda's main topics of focus include academic mental health at all career levels, highlighting mental health as a disability, and tackling ableism in research.

Alex N. Baker is a PhD candidate at the University of Warwick Department of Chemistry. His research with industry focuses on the use of glycosylated nanoparticles in lateral flow tests for less economically developed countries. Alongside his research Alex also has a passion for public engagement and outreach especially with traditionally underrepresented groups. He is also interested in sustainable curriculum development and delivery – notably anti-casualisation.

Ana E. Cartaya is a Pharmacology PhD candidate at the University of North Carolina at Chapel Hill. Her research centers on the delivery of antioxidant response activating nanoparticles to the vasculature, and investigating their potential for prevention of vascular disease. She is committed to supporting first-generation and underrepresented students in their journey to STEM PhD programs.

Dr. Zoë J. Ayres (she/her) is an analytical scientist by background, with an undergraduate degree in Forensic Science, Masters in analytical chemistry and PhD in electrochemical sensor development. After spending several

years in academia post-PhD, she moved to industry, and is now a Senior Scientist in the water industry. Zoë is also a mental health advocate in her spare time, working towards improving mental health in research settings, primarily focusing on academic mental health. She raises awareness of the common issues people face throughout academia through various campaigns, talks and initiatives.

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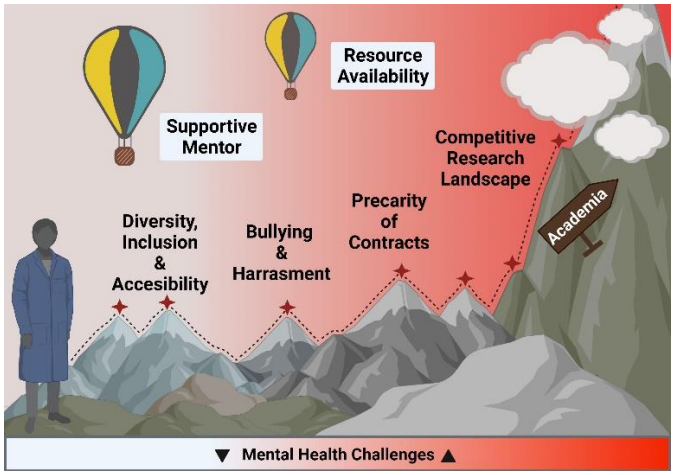
Graphic:



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In this paper, we focus on some of the key aspects of research culture that impact STEM researcher mental health in academia: bullying and harassment; precarity of contracts; diversity, inclusion, and accessibility; and the competitive research landscape, as well as exploring why mental health matters for our researchers. Further, we provide some key recommendations and actionable steps institutions can take to make research in STEM an inclusive for all.

Institute and/or researcher Twitter usernames:

	Twitter handle(s) (optional)
Juanita C. Limas	@proud_rpcv
Linda Corcoran	@LindaCCor
Alex Baker	@AB_wan_Kenobi
Ana E. Cartaya	@SaborRedox
Zoë J. Ayres	@ZJAyres, @AcademicVoices

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