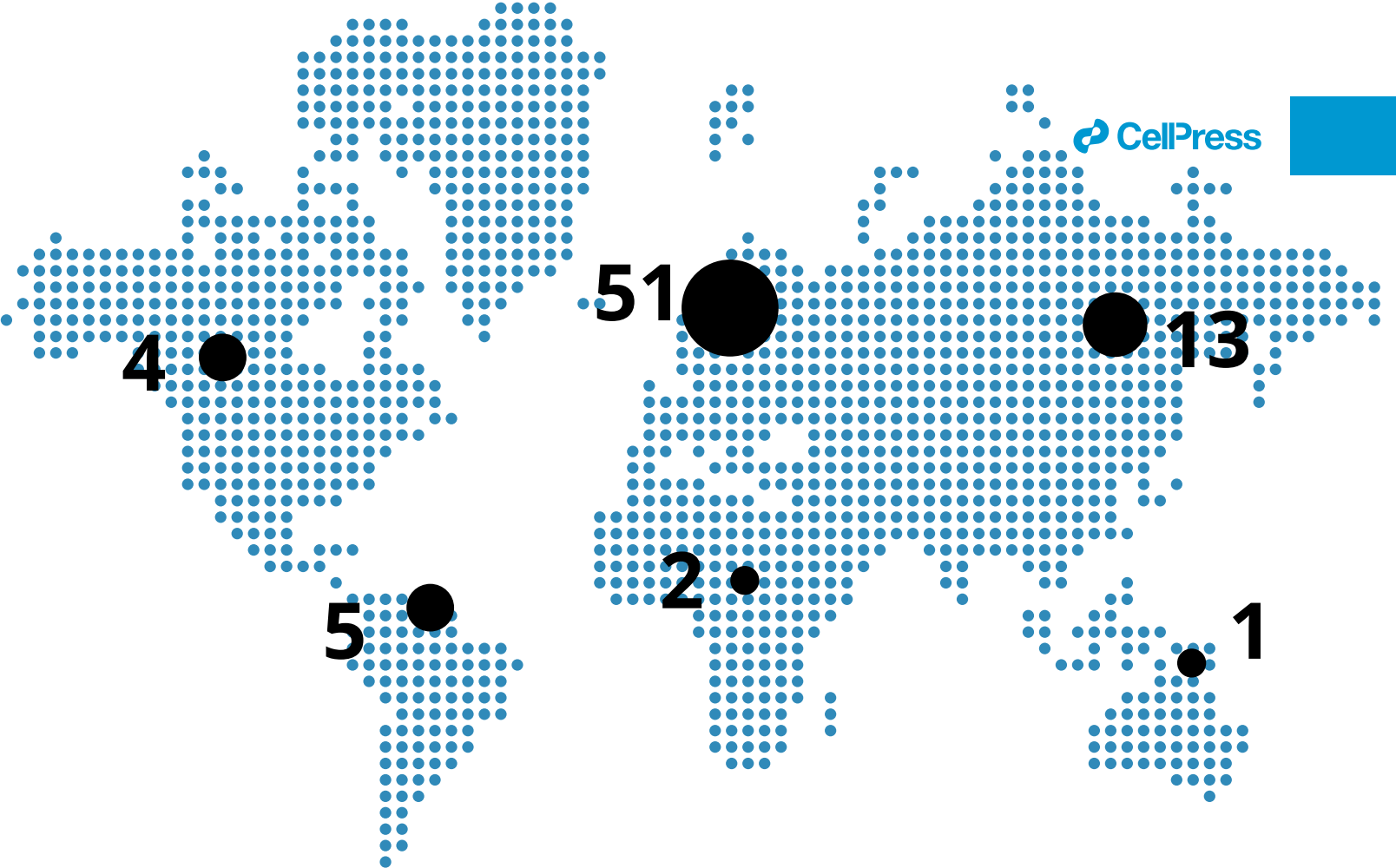




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76/105 RESPONDENTS SHARED THAT THEY CAME FROM EUROPE, AUSTRALIA, ASIA, NORTH OR SOUTH AMERICA



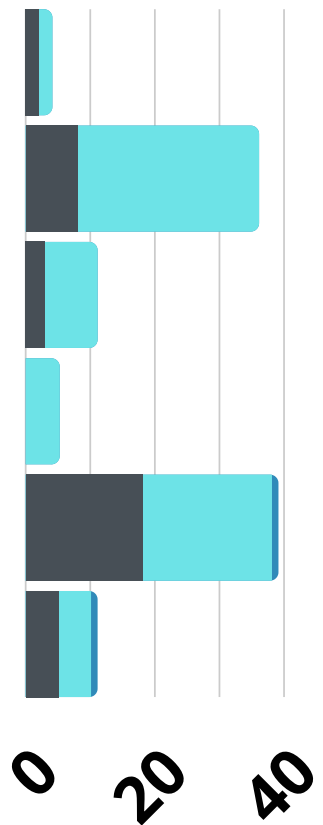
MEN 33%

WOMEN 65%

PREFER NOT TO SAY 2%

Masters Students
PhD Students
Post Docs
Research Fellows
Independent Researchers

Others



Backstory

Managing research throughout COVID-19:
Lived experiences of supramolecular chemists

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The international Women in Supramolecular Chemistry network believes that taking an area-specific approach effectively supports equality, diversity, and inclusion. Science lacks diversity, and this is intersectional. We share effects of coronavirus disease 2019 (COVID-19) by triangulating findings from an online survey, a collaborative autoethnography, and reflective group research meetings. We show how qualitative research with the community offers insights into challenges and supports individuals, and we demonstrate that research leaders have often taken responsibility for their teams' mental health and well-being at the cost of their own.

A history of structural and systemic barriers to retention and progression, combined with a culture of microaggressions and discrimination, has resulted in an under-representation of women in science.¹ Despite initiatives aimed at increasing the numbers of women, and near gender parity at undergraduate and postgraduate degree levels, women remain under-represented at the most senior levels of academia.² Women in academia in any discipline face multiple barriers,³ and for those in science, technology, engineering, and mathematics (STEM), these are exacerbated.⁴ In this article, we focus on women as a marginalized group within supramolecular chemistry,⁵ and we recognize that many of the barriers faced by these individuals are also experienced by other marginalized genders and those with caring responsibilities. Note: we use the term "marginalized genders" to include non-binary people and trans men; trans women are included in the word "women." We include a further discussion on the barriers faced by women in academia in [supplemental information section S1](#). Please also see [section S1](#) for a full discussion on the barriers faced by women in academia. Marginalization due to any protected characteristic—such as gender, race, religion, sexuality, or disability—is intersectional,⁶ meaning that barriers compound. It should be noted that caring responsibilities are not a protected characteristic, and thus it is particularly difficult to address caring-related discrimination because there is no specific legal framework like there is for other types of discrimination.

Within chemistry and other disciplines in science, part of developing as an independent researcher is becoming a principal investigator (PI) and running a successful research group. Differences in leadership style and workplace culture, along with the differing demands placed on those who are marginalized (e.g., an expectation to perform EDI [equality, diversity, and inclusion] roles, act as a formal or informal

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Above image: Demographics of respondents to online survey.



mentor, and take on additional administrative or pastoral duties), can have an impact on an individual's career progression. The coronavirus disease 2019 (COVID-19) pandemic has placed additional burdens and work on the higher-education sector, academics, and research staff. Although the pandemic is not yet over at the time of writing, there are already general indicators that these burdens have been borne disproportionately between men and women. Women's publication rates have been affected to a greater degree than those of their men counterparts.⁷ What, then, are the impacts of COVID-19 on an already marginalized group?

Here, we move beyond numbers to explore the lived experiences of those working in supramolecular chemistry and highlight experiences of being part of or managing an academic research group in "unprecedented times." To achieve this, we triangulate data from three qualitative sources: (1) an online survey asking the community questions about experiences related to COVID-19, (2) an international ongoing collaborative autoethnography study with women research-group leaders, and (3) the results of reflective group workshops and meetings held with two research groups in the UK and US with women PIs. We have intentionally used creative and reflective research approaches within an embodied inquiry⁸ that centers the emotional, lived experiences of participants. In a process of reflexive thematic analysis,⁹ we identified themes from the transcripts of the collaborative autoethnography meetings. These themes represented "hot spots" or points of interest that resonated with the research team and warranted further analysis. We then analyzed the transcripts of the reflective group meetings with respect to the identified themes before triangulating with data from the wider supramolecular community from the online survey responses. The aim of the analytic process was not to produce generalizable results but rather to evoke responses that resonated with individual, lived experiences of the phenomena under investigation.¹⁰

Here, we move beyond numbers to explore the lived experiences of those working in supramolecular chemistry and highlight experiences of being part of or managing an academic research group in "unprecedented times."

General remarks

The [supplemental information](#) includes a discussion of women in academia; information on ethical approval and funding; a discussion of our approach to using qualitative research, including collaborative autoethnography; the methods used for data gathering and analysis, including details of the survey; details of the reflective meetings; details of the collaborative autoethnography; and supplemental references.

Participants

Online survey

The online survey was open to respondents of all genders and all career types within and directly supporting the international supramolecular chemistry community from December 2020 to May 2021 and collected 105 responses in that time. Respondents were asked to self-identify their ethnicity and/or nationality, which included white, Indian, South American, Latino, Turkish, Italian, British-Cypriot, European, Asian, Chinese, German, and Hispanic. One respondent identified as LGBT+, and one identified as neurodivergent.

In addition to recording demographic data, many of the questions were open; respondents described their experiences with COVID-19 and whether they had caring responsibilities. We had no responses that we could specifically assign to those in administrative or technical roles, although they would have been impacted by

COVID-19. However, these individuals could have identified themselves as “other” (Table S1). Table S1 shows a breakdown of the intersection of career stage, gender, and caring responsibilities.

Collaborative autoethnography

All 12 participants of the collaborative autoethnography (CA) group are early- to mid-career researchers in academia. They all identified as women and were based in the US (three), Germany (two), Italy (one), and the UK (six). Three members of this group identified as having a disability, chronic illness, or neurodivergence. They did not disclose or discuss sexuality. Eleven presented as white, and one is Black. The CA study was initiated in September 2020 and is ongoing.

Reflective group meetings

The reflective group meetings began in January 2021 and are ongoing. Meetings are held every 2 weeks and last 1 h each time. Eleven of the 14 participants identified as women. They had a diverse range of nationalities, including Indian, South African, Turkish, Lithuanian, and Puerto Rican. Four identified as having a disability, chronic illness, or neurodivergence. Thirteen were postgraduate students, and one was a post-doctoral research associate.

Findings

The themes that we share here relate to the lived experiences of being in or running research teams in relation to the challenges of managing a team’s mental health during lockdown, returning to labs with split teams and rotas as a result of social-distancing requirements, and the logistics of projects. In addition, we address the emotional impact of managing teams and mitigating damage and the positive effect of taking time to reflect and connect with others.

Mental health and isolation

The COVID-19 pandemic and lockdown had a negative impact on many people’s mental health, and unsurprisingly, this was reflected in the CA participants’ responses, as they shared concerns relating to the effects of this on their group members:

My group are [sic] so disconnected. We’re doing Zoom meetings but the sessions are not so helpful.

I had a new international student start and I’m so worried that they aren’t able to connect with anyone.

They’re just fragmented and I don’t know what to do to make it better.

The research-group students echoed the impact of COVID-19 in their descriptions of the effect on themselves. Many of the survey respondents also discussed the negative impact of COVID-19 on their mental health:

The Covid-19 is the bad phase in my life.—Post-doc (woman)

Working from home was a real struggle and has had hugely negative impacts on my mental health.—PhD student (woman)

During the March April lockdown I got properly depressed for the first time in my life.—Independent researcher (man)



Research group members' reflections on the impact of COVID-19.

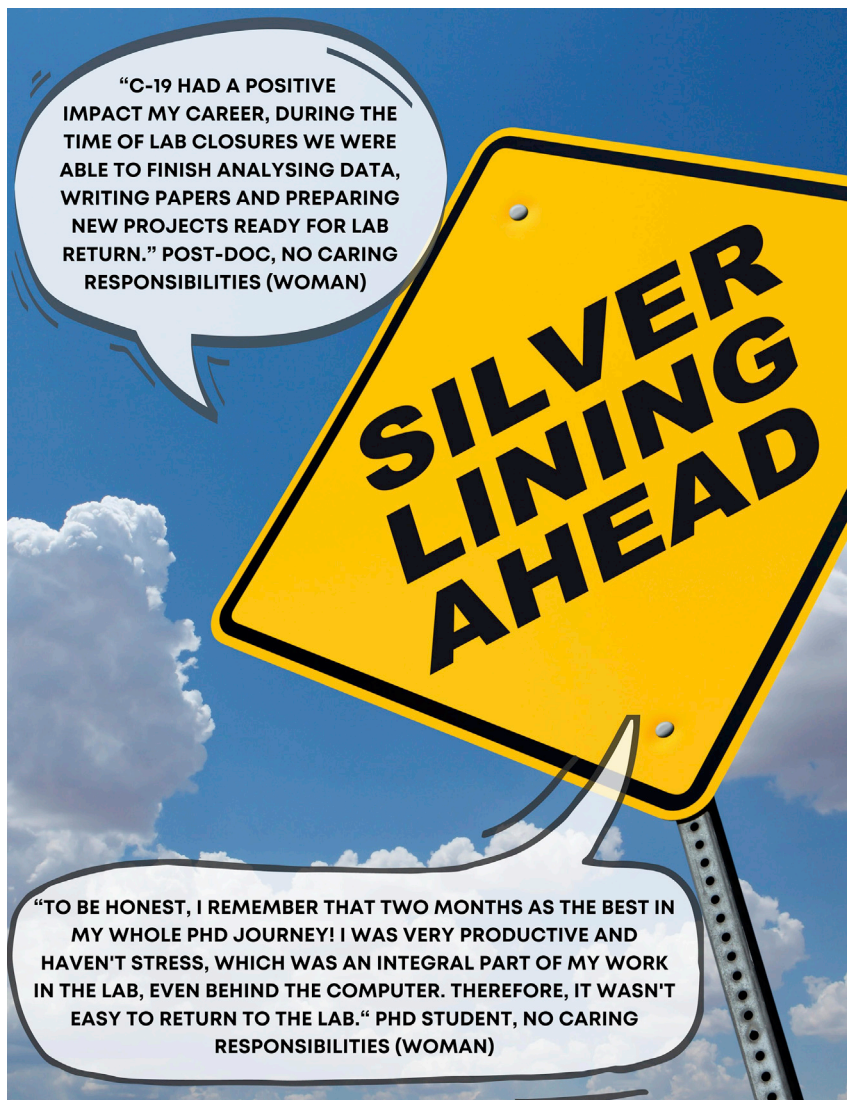
However, some without caring responsibilities shared that they were able to look after their mental health better than before:

But it also meant that I was able to look after my mental health a little better, having half of the day to do some healthy activities and spend time on myself.—Master's student (woman)

I was able to make proper meals during the day and looked after myself better.—PhD student (woman)

The majority of survey respondents reported that COVID-19 had an impact on their productivity, reflecting the experiences of the research and CA groups.

My productivity and efficiency are through the floor, but it is what it is.—Independent researcher (man)



The silver linings of COVID-19.

Not all saw COVID-19 as negative. A woman PhD student shared: "It worked out well for me because I had all the data from the lab so I could write a publication easily from home."

From the online survey, the biggest indicator of having a tough time through lockdown was not gender or career stage but whether an individual had caring responsibilities. It is worth noting, however, that although in our survey the gender split of independent researcher respondents was 22 women and non-binary people to 17 men, the proportion of women and non-binary people with caring responsibilities was just 55% compared with 65% of men independent researcher respondents. These trends are indicative of the issues that chemistry has in retaining women after their PhD¹ but do not reflect data on caring responsibilities within academic populations¹¹ or wider society, where women disproportionately bear the labor of caring duties, particularly for young children who were not able to attend school during the COVID-19 pandemic.¹² It could also reflect participation bias given that it is

possible that a man researcher with caring responsibilities might be more sensitive to the impacts of COVID-19 on researchers than the average and therefore more likely to respond to the survey. (Please see [section S1](#) for a discussion on mothering in academia.) We should also note that although our survey respondents were wholly from academia (though the survey was open to all), we acknowledge that administrative and technical staff contributing to the goals of academic PIs would have been impacted too, and their voices are even less visible than those we share here.

Working from home a lot, nightmare looking after a small child and trying to get work done whilst sharing childcare. Essentially getting about 3 hours a day of work done for many months, and trying to not let anyone down. Very difficult. Also no home office so that was fun.—Independent researcher (man)

This has been utterly exhausting. One of my senior colleagues without caring responsibilities actually said out loud during a staff zoom call that they'd "rather enjoyed the opportunity to focus on papers and grants, and they'd got a lot done." (While I am pleased for them, I was not alone in feeling like it was a tone-deaf comment, that sadly presages the onset of several years of division between those who were able to boost their careers as a result of the pandemic and those who were not).—Independent researcher with caring responsibilities (man)

We would like to note here that quotes have been included verbatim, and we recognize that the phrase "tone deaf" in this last quote is ableist language.¹³

Return to labs

Many research labs were shut completely for extended periods of time during the COVID-19 pandemic before the initiation of phased returns governed by local social-distancing requirements. The ways in which these returns and social distancing were managed varied from lab to lab; some options included split days, 1 week on followed by 1 week off, and 3 days on followed by 4 days off. Reducing lab capacity had impacts on group dynamics. Rota systems that split individual lab groups were the most problematic for the CA group. Reducing time in the lab also had an impact on the kinds of experimental work that could be completed. The CA group reflected:

My group are [sic] divided.

It's been a challenging process. I have a challenging line manager who tells me "you just have to prioritise."

I had them all working on a review paper, now they need to get back to experimental work, and I had to pivot projects and come up with stuff that will work in the rota they have and the time they have.

From our reflective group meetings, the UK research-group students were not split; they shared a space with another research group, and the two groups alternated time in the lab on a morning-afternoon rota. They spoke about the changed work conditions:

We've been in shifts in the lab, split with another group, so we haven't been split. We're lucky.—PhD student (woman)

We've had to change what we do – we can't run all day experiments any more [because] we're only in 1–5.—Master's student (woman)

I got lots done – worked on data in the morning then went into the lab after lunch.—PhD student (woman)

The survey respondents agreed that split group working and reduced time in the lab were both challenging, particularly when communication with supervisors and PIs was not clear. There was a lot of anxiety over the return to labs, particularly from women PhD students:

It has been immensely emotionally draining in returning. It requires additional effort each day to focus on work whilst the numbers are/were rising so steadily.—PhD student (woman)

Finding return to labs hard, difficult to use the shared equipment safely without feeling stressed. I feel pressure to make up for lost time so the return to labs has been very busy.—PhD student (woman)

Return to the labs wasn't too bad but struggled to do most work efficiently because of rotas in place.—PhD student (woman)

Our supervisor chose who got to go back and only informed those individuals at the last minute, leaving everyone else wondering if they are to stay at home or just haven't received his email yet. Post docs got to go back first and didn't take the time to talk to the rest of the group.—PhD student (woman)

For research leaders, they echoed the CA group's experiences:

Returning to labs has made dealing with PhD students a bit better, less reliant on me to tell them what to do. But they continually pester me asking when the rota will change (we have split the group in half and are doing week in and then week out). This isn't helped when other labs are in 100% of the time due to them having larger labs or smaller groups. Head of school says there is no more space, seems unlikely, just poorly organised space. ... We have been told to prioritise teaching from up high, but also from college we are asking where all the grants are, where are the papers since we've had all this extra time.—Independent researcher (woman)

As this quote makes clear, the emotional impact on research leaders carrying the burden of their research groups, as well as the pandemic, was huge.

Emotional impact

The emotional impact of the pandemic was also a frequent topic of conversation within the CA group:

I am very distracted and anxious. Lacking in motivation and finding it hard to build a head of steam.

Someone died of COVID whilst lecturing in South America – is HE [higher education] worth dying for?

The survey results showed that proportionally more women than men talked about the emotional impact of COVID-19, and students spoke about the importance of their team and not being able to see peers or socialize:

I wasn't able to get to know my team as well as I might have if we were able to socialise more.—Master's student (woman)

With it came a lack of communication that pushed me into anxiety and despair.—PhD student (woman)

The CA group meetings became a safe space for sharing and processing emotions during the COVID-19 pandemic. The participants were able to be honest, and as a result they felt less isolated and helpless:

I have so much anger and I don't know why. I'm frustrated I don't have clean data. I can't sleep. I have so much anxiety.

It's week 4 of home-schooling and the wheels are falling off. I needed to sleep and was looking at paper drafts instead.

I'm just fire-fighting the whole time. There's so much pressure.

One research group from the UK reflective group meetings was aware of the load its PI faced:

I worry about [name redacted] she's under so much pressure.—PhD student (woman)

She's very hands on with the team. It's quite a special group.—Post-doc (woman)

The research leaders responding from the survey also spoke about the impact of COVID-19 and the emotional load:

I feel that my research team and I responded to the challenges that covid posed to us with resilience and agility, the main impact to myself was that amount of my personal and emotional resource was needed [sic] to support others and ensure the productivity of my team was maintained. This has left me drained and exhausted.—Independent researcher (woman)

I worked from home. Its [sic] arguably the hardest thing I've ever done. I have 2 kids (age 8 and 12) and they are somewhat autonomous, but it was still difficult. I worried about everything ... especially the well-being of my group, and of course our productivity which effectively fell to zero.—Independent researcher (man)

The most negative effects for my research, besides the huge amount of extra work for me that covid has necessitated to sort out Dept & university matters, is not seeing individual members of my group in person, other than by zoom, for more than a year. Without face-to-face interaction one cannot really understand how everything is going, personally and



The emotional load of research group leaders.

professionally, for everyone and on particular projects.—Independent researcher (man)

This emotional load of responsibility for one's research group, unrecognized in workload-allocation models and literature, contributed to the feelings of firefighting and burnout seen in the CA group and the independent researchers responding to the survey.

Discussion and conclusion

The CA group found the space to reflect, process, and share with a community of supportive peers. The meetings, rather than being another burden on their time, became points of connection and support. The importance of community for women in science is widely recognized.^{14,15} Given the pre-COVID-19 context of the lack of diversity within chemistry,¹⁶ it is little surprise that women, who are often the main caregivers within the home, have been severely impacted by the COVID-19

pandemic.¹⁷ Our survey demonstrated that it was caring responsibilities rather than gender¹⁸ that correlated with less positive experiences, and this could be extrapolated to include the duty of care that many independent researchers felt toward their research groups. It must be noted that our survey sample had a higher proportion of women respondents (65%) than would be representative of the supramolecular and chemistry communities.¹⁶

The importance of community (or lack thereof through lockdown and social isolation) was another important factor contributing to personal experiences. Communities and networks are vital for those who are marginalized.^{3,15} Our previous work demonstrated the value of reflexive and creative approaches in helping to build communities and networks,⁵ allowing members to identify and disseminate their experiences to better understand the impact of marginalization. The ongoing work with the CA and research groups supporting their reflective and reflexive processes¹⁹ has been valued by all participants for the opportunity to share, connect, and feel less alone. Similarly, feedback from the mentoring circles organized through the international Women in Supramolecular Chemistry (WISC) network has emphasized the positive impact of regular and supportive meetings with peers.

The challenges that students, post-docs, and independent researchers have faced in supramolecular chemistry are likely to echo those faced by academics and researchers across not only the many fields of chemistry but also other disciplines as well. What is novel in our approach is that findings presented herein are data triangulated from three sources, together with the use of a community-specific group to address these challenges. As such, rather than looking at the problems from the outside, we as a community are exploring these issues as a means to address them. Rotas have had a negative impact on the mental health, communication, and productivity of research groups. Having caring responsibilities was the largest factor for all participants regardless of age, career stage, or gender. The emotional load of managing a research group through COVID-19 was an unexpected burden that was borne unevenly across the academic community. Within STEM, it fell predominantly on those who were more senior in their careers and who were thus more likely to also shoulder additional senior management responsibilities. This last factor, largely unrecognized by universities, without doubt contributed to the decision made by some women survey respondents to leave academia during or as a result of the COVID-19 pandemic.

I have a nursery age child and not childcare or any family near by [sic] so I basically couldn't do my job, which was increasingly more difficult with managing PhD students who couldn't go into lab ... I told my line manager about my lack of ability to do my job, and he just told me to make a note of it for our PDRs [Planning Development Review meetings], which have now been cancelled.—Independent researcher (woman)

Upon returning to lab, I had lost all motivation to work. This event contributed quite strongly to my decision to leave academia.—Woman identifying as "other"

If chemistry and science are to continue to tackle the EDI crisis, it is imperative that the impact of COVID-19 be ameliorated. This is of particular importance for those with caring responsibilities and for those who are from marginalized groups where progression is limited.

If chemistry and science are to continue to tackle the EDI crisis, it is imperative that the impact of COVID-19 be ameliorated. This is of particular importance for those with caring responsibilities and for those who are from marginalized groups where progression is limited.

In a survey of 2,888 mothers in academia, Kovarovic et al.¹⁷ identified many practices that did not help, as well as nine themes of practices that did, from 2,498 responses. These included the following:

- (1) Specific, genuine support from managers and/or peers
- (2) Increased flexible work opportunities
- (3) Additional leave options
- (4) "Different" Fridays (i.e., implementation of a day with no meetings or shorter work hours)
- (5) Equipment and skills needed to work from home
- (6) Teaching, marking, or other workload relief
- (7) Financial benefits
- (8) Furlough
- (9) Making children and home life visible at all levels¹⁷

Although some of the general recommendations that Kovaric et al. give in their report would be beneficial to women and caregivers in supramolecular chemistry and other science disciplines—such as specific, genuine support, flexible work opportunities, workload relief, financial benefits, and making children and home life visible—it is clear that the additional pressures of working within a lab and of running a lab and research group need additional responses from institutions and funders. There are a number of ways in which this could be achieved in the areas of chemistry where the overarching problem has been the loss of lab time, which has varied depending on lab size, the number of researchers in a group, local rules on social distancing, etc. For example, master's and PhD students can be supported by being given extra time to complete their degree and, in the case of post-docs, contract extensions; however, these options are likely to have financial implications for the individuals and organizations that would also need support. It must also be acknowledged that this could just push the problem onto the next cohorts of students, reducing their funding and time. An alternative could be to accept less original research and more review papers for progression and promotion. Aid for PIs could include the provision of no-cost extensions, the ability to move deliverable deadlines, and risk-mitigation planning to happen as part of this process. However, we should also acknowledge that not every researcher would be affected to the same degree, and it is sensible to calibrate responses depending on (1) the lost time for each individual researcher, (2) personal intersectional factors (caring responsibilities, etc.), and (3) some additional time that acknowledges the widespread mental-health and stress struggles faced by everyone.

It will be necessary to track whether the long-term impact of COVID-19 increases the attrition of women from chemistry and decreases the progression of minority groups.^{1,16,20} We suggest that a major tool in the arsenal used to address the lack of gender balance and diversity in science generally, and the impact of COVID-19 on those groups specifically, is establishing and growing networks of area-specific communities. This allows space for individuals to reflect on and share their lived experiences so that they are less isolated and marginalized. We offer WISC as a blueprint or model of how this could be achieved in an area-specific field and replicated across disciplines, borders, and communities.

We suggest that a major tool in the arsenal used to address the lack of gender balance and diversity in science generally, and the impact of COVID-19 on those groups specifically, is establishing and growing networks of area-specific communities.

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AUTHOR CONTRIBUTIONS

J.S.L. led data collection, analysis, and writing. J.R.H. contributed to data collection, analysis, and writing. S.K. contributed to data analysis. A.J.M., C.J.E.H., C.C., M.K., E.R.D., A.G.S., K.M.H., D.W., N.B., and L.K.S.v.K. contributed to data collection. K.A.J. contributed to research design and writing. M.J.H. contributed to research design.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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