



**Commonwealth
Chemistry**
Federation of Chemical Sciences Societies

A Sustainable Chemistry Workforce for a Sustainable Future



Unlocking the potential of early career chemists
across the Commonwealth

commonwealthchemistry.org

Contents

Acknowledgements	04
Foreword	05
Executive summary	06
Introduction	08
Findings	09
Barriers to success	10
Research	16
Inclusion and diversity	21
Non-technical skills	25
Collaboration across the Commonwealth	28
Recommendations and commitments	33
Appendix: Methodology	36
References	39

Acknowledgements

Thank you to everyone who completed the survey and to all the focus group participants for sharing their experiences and insights for this report. Also members of the Commonwealth Chemistry Executive Board who helped shape this project:

- Dr Vicki Gardiner FRACI CChem ComIEAust EngExec
- Professor James Darkwa FAAS, FGAS, FSACI
- Dr Michael Forde MRSC
- Professor Peter Mallon MSACI
- Professor Ishmael Masesane
- Professor Sarah Masters FNZIC FRSC FHEA
- Dr Deborah Nicoll-Griffith MCIC
- Professor Sourav Pal FRSC, FNA, FASc, FNASc
- Professor Priyani Paranagama
- Dr Robert Parker CSci CChem FRSC
- Mr Roger Stapleford MRACI CChem, CPA
- Professor Choon Hong Tan

And the Commonwealth Chemistry Secretariat for the design of the research and the delivery of the report:

- Dr Ale Palermo FRSC
- Dr Sarah Thomas CSci CChem FRSC
- Mrs Rachel Thompson

For further information please contact
secretariat@commonwealthchemistry.org

Foreword



The United Nations Sustainable Development Goals (UN SDGs) are more urgent than ever. From the impacts of climate change to the inequalities exacerbated by the pandemic, we have some big problems to solve.

Chemistry has a key role to play, and that is why we must pay attention to the sustainability of our discipline itself. Commonwealth Chemistry is determined to encourage and support the next generation of chemists right across the Commonwealth.

We are proud to have led the first ever survey of early career chemists in the Commonwealth to understand their challenges and needs and identify common opportunities. While they had a range of perspectives, they also shared many experiences.

Across the Commonwealth, early career chemists are tackling key sustainability challenges. However, they are being held back by a range of barriers, including promotion opportunities, research mentoring or support, and limited access to equipment and consumables.

Overall, early career chemists in low and middle income countries face more significant barriers than their peers in high income countries, and women face greater challenges than men. This is something that must be addressed. Equality for all is one of the central pillars of the Commonwealth and of Commonwealth Chemistry.

There is also much to be gained from working together across Commonwealth nations. While many early career chemists are collaborating with scientists in other countries, a lack of funding for travel and networks also limit their ability to do so.

The good news is that our Federation may be well placed to help address some of these barriers. We are using the findings of this report to enhance our strategy in support of early career chemists right across the Commonwealth, so they can contribute fully to society in solving global challenges. However, we cannot do this alone, we encourage others, including The Commonwealth, universities and funders of research, and employers to take the findings of this report on board.

A handwritten signature in black ink that reads "Vicki Gardiner".

Dr Vicki Gardiner
President, Commonwealth Chemistry

Executive summary

We are the Federation of Commonwealth Chemical Sciences Societies – or more simply, Commonwealth Chemistry. Bound together in the spirit of the Commonwealth, we champion equal opportunity for all, drive innovation, and promote excellence in the chemical sciences for the benefit of the Commonwealth nations and their people.

We are committed to supporting early career chemists as part of that mission. We conducted the first ever survey of early career chemists across the Commonwealth to find out more about the barriers they face. This report presents our findings.

Our key findings

Early career chemists across the Commonwealth are contributing to the United Nations Sustainable Development Goals (UN SDGs).

- More than nine in ten early career chemists in the Commonwealth are engaged in research related to the UN SDGs.
- Early career chemists in low and middle income countries are more likely than their peers in high income countries* to research topics related to health, food and agriculture, and water and the environment.

Early career chemists across the Commonwealth are being held back from fulfilling their potential.

- A lack of promotion opportunities, mentoring or support, and limited access to equipment and consumables are the most common barriers.
- Difficulty in accessing funding for research is also a significant challenge for early career chemists across the Commonwealth.
- While many early career chemists are collaborating on research with other Commonwealth countries, a lack of funding for travel and networking opportunities limit their ability to do so.
- Many early career chemists need more support in writing funding and grant applications, getting scientific papers published, and seeking out coaching and mentoring.

Early career chemists in low and middle income countries face bigger barriers than those in high income countries.

- Early career chemists in low and middle income countries are more likely to face challenges related to accessing equipment and consumables, securing funding and time for research, funding for travel related to career development, and accessing networking opportunities.
- Early career chemists in low and middle income countries do not have the same access to scientific publications as their peers in high income countries, as they are more likely to rely on Open Access sources.

Women face bigger barriers than men.

- Women early career chemists are more likely than men to be held back by prejudice, family commitments and a culture of long working hours, although these barriers also impact men.
- Women are also less confident than men in writing funding applications and getting published.

* World Bank lending group definitions were used to classify countries as low, middle or high income. Responses from low and middle income countries were analysed together to avoid reducing the sample size, as there were comparatively fewer responses from these countries than from high income countries. See Appendix for more detail on the methodology used.

Our key commitments

We will empower early career chemists to build their networks, including by setting up a Commonwealth Chemistry Early Career Network.

We will support early career chemists to develop crucial non-technical skills by working with partners to increase access to professional development opportunities, training courses and careers guidance.

We will champion equality in chemistry by sharing good practice and empowering other chemical sciences organisations to improve inclusion and diversity.

We will facilitate knowledge sharing between early career chemists across the Commonwealth, including by providing free online access to Chemistry World and engaging with policymakers.

Our key recommendations

The Commonwealth should use its convening power to encourage greater scientific collaboration, enhance support for early career scientists through its capacity building programmes, and engage with member countries to promote inclusion and diversity in the chemical sciences.

Funders of research should increase the number of grants targeted at early career chemists, make more funding available for equipment and travel for collaborations, and consider the diversity in the teams and institutions that they fund.

Universities and chemical sciences employers should increase job security, provide training in non-technical skills, and provide coaching and mentoring for early career chemists; promote family friendly work practices; consider equipment sharing arrangements; and gather data on and improve inclusion and diversity.

See page 33 for our recommendations and commitments in full.

Introduction

We need a sustainable community of chemical scientists to achieve the UN SDGs.

A strong and diverse community of chemical scientists is essential if we are to create a sustainable world. Chemistry is key to solving many of the most pressing problems we face, from clean water to air pollution.

Commonwealth Chemistry exists to inspire, celebrate and elevate the role and practice of the chemical sciences for the benefit of Commonwealth nations and their people. Early career chemists are the future leaders of our field. Enabling them to realise their potential is central to our mission.

Unfortunately, chemists at the early stage of their career often face significant barriers to success. In 2020, we held our first poster event online, showcasing the impact that early career chemists from across the Commonwealth are making with their research. We also gained some initial insights into the barriers they face.

We wanted to better understand these challenges and how to help early career chemists succeed, so we conducted the first ever Commonwealth-wide survey of early career chemists.



Findings

Barriers to success

Early career chemists across the Commonwealth are being prevented from achieving their full potential, with a lack of promotion opportunities, mentoring or support, and limited access to equipment and consumables being the most widespread challenges.

Four in five Commonwealth early career chemists struggle with a lack of promotion opportunities, three in four are negatively impacted by a lack of mentoring or support, and seven in ten are limited by access to equipment and consumables.



Early career chemists also face a range of other barriers, with **more than half** saying the expectation of long working hours, publication prerequisites, family commitments and the expectation to relocate to another institute negatively impact their work.





Some early career chemists also struggle with a lack of job security.

Although the survey did not specifically ask about job security, some survey and focus group (see Appendix) participants highlighted the difficulty of relying on short-term contracts, which makes it hard to plan for the future.

"Short term contracts cause a lot of stress and uncertainty and force me to work way more hours than paid for."



Early career chemist, high income country

This is consistent with the wider evidence on barriers faced by early career scientists. For example, a recent survey of early career researchers in science, technology, engineering, mathematics and medicine in Australia found that job insecurity was a major factor negatively impacting job satisfaction for respondents, along with workplace culture and mentorship¹.

Formal and informal mentorship can make a real difference.

Participants in our focus groups stressed the importance of opportunities to collaborate with senior colleagues. This can be an invaluable way of gaining research experience and skills, as well as advice on other aspects of their work, such as writing funding applications.

Some early career chemists said they had limited access to mentoring, while others shared positive experiences, including seeking support from colleagues in other institutions.

"I think that because there weren't many people that I knew who I could approach to help me take my next career step, I've struggled to progress."



Early career chemist, high income country

A supportive PhD supervisor can have a particularly significant impact. Some participants said their supervisor had provided ongoing opportunities for collaboration, networking and publication.

"My PhD supervisor has been a top strength, continuing to work with me [after my PhD]... That has been good from the perspective of continued collaboration and eventual publication."



Early career chemist, middle income country

The wider evidence also suggests mentorship is key. A large-scale worldwide survey of doctoral students found that mentorship contributed more to respondents' overall satisfaction with their PhD programme than any other factor².

In contrast to Commonwealth early career chemists, a relatively high proportion of respondents to the survey were satisfied with the mentoring they received from their adviser. However, nearly one in four (23%) said they would swap advisers if they could and only one in six (15%) said they found useful career resources at their institution².

Early career chemists in low and middle income countries are more likely to face challenges in accessing equipment and consumables.



More than nine in ten early career chemists from low and middle income countries said access to equipment and consumables negatively impacts their work, and more than two thirds of them said this does so to a great extent.



While this is also an issue in high income countries, it is not as widespread. **Six in ten** early career chemists in high income countries said access to equipment and consumables was a barrier, with only one in five saying it negatively impacts their work to a great extent.

This is consistent with wider research that shows that overall there is less funding available for research in low and middle income countries³, including Government funding⁴.

Early career chemists said a lack of equipment and consumables makes doing research more difficult and time-consuming. It also negatively impacts teaching as students cannot be trained in important technical skills. Even when money has been invested in equipment, sometimes it is difficult to run or maintain it due to a lack of technicians or funding for key materials.

The procurement process compounds the challenge.

In addition to funding challenges, many early career chemists in low or middle income countries highlighted that the procurement process for chemicals and other materials can cause significant delays. This is due both to institutions' internal processes and a lack of local manufacturing capacity, which means that many key materials must be imported.

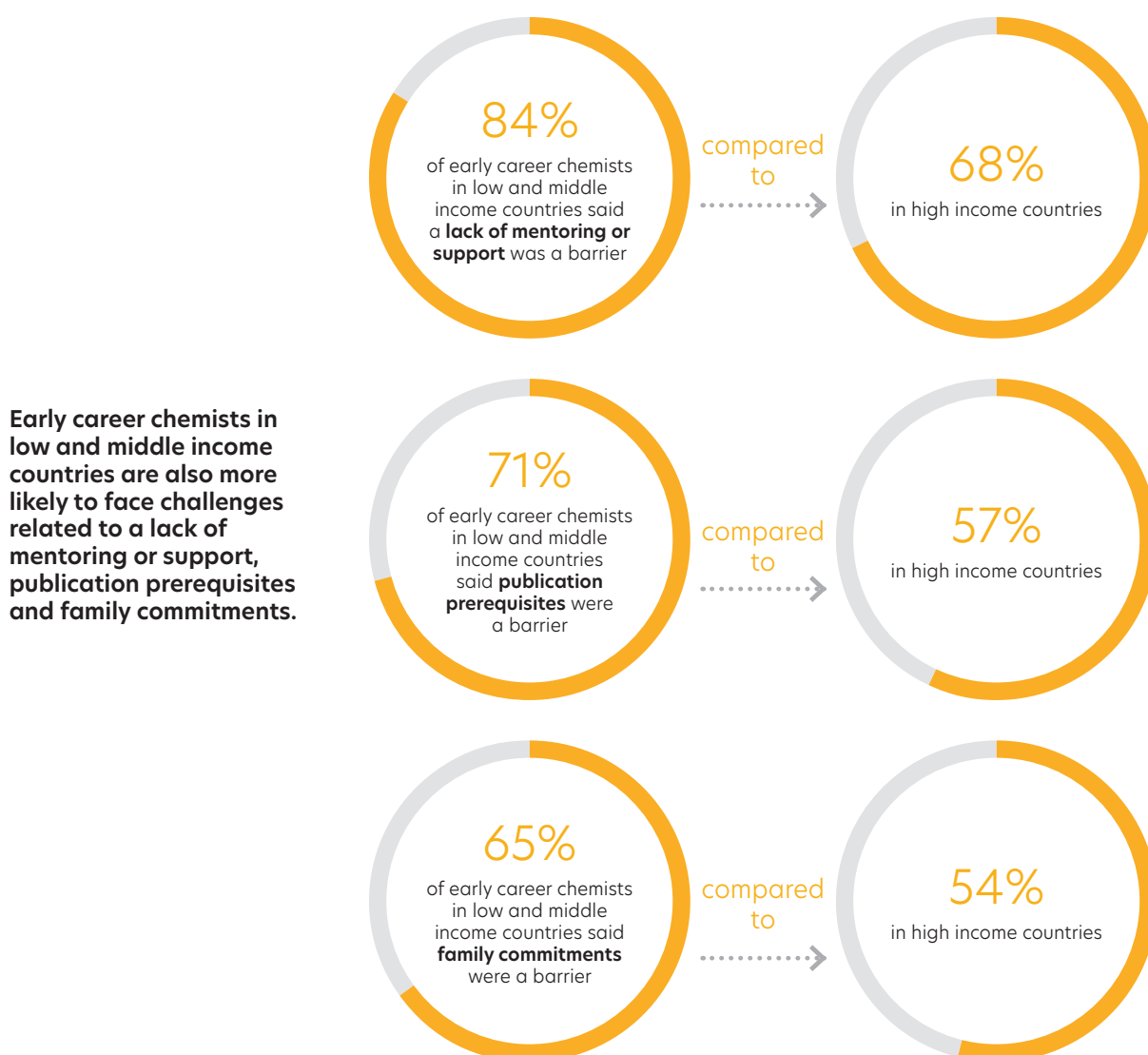
"We have to import most of the chemicals we need and the procurement process is exhausting. It can take a year to buy a piece of equipment."



Early career chemist, low income country

Similarly, when equipment (or the expertise to maintain it) is not available locally, samples have to be sent for analysis elsewhere either within the country or abroad. This slows down research and sometimes results in samples being compromised.

However, participants also shared examples of how they are collaborating with colleagues to overcome some of these barriers, for example generating income to maintain equipment by sharing it with other institutions.





Spotlight on Impact



A new drug candidate to treat Alzheimer's Disease

Thimmaiah Govindaraju is a chemist based at the Jawaharlal Nehru Centre for Advanced Scientific Research in India. His research group recently discovered a possible drug candidate for treating Alzheimer's disease. The team designed and synthesised a set of novel small molecules and identified a lead candidate that reduces the build-up of amyloid in the brain that causes the disease, and significantly reversed cognitive decline in mice. The drug candidate is now being considered

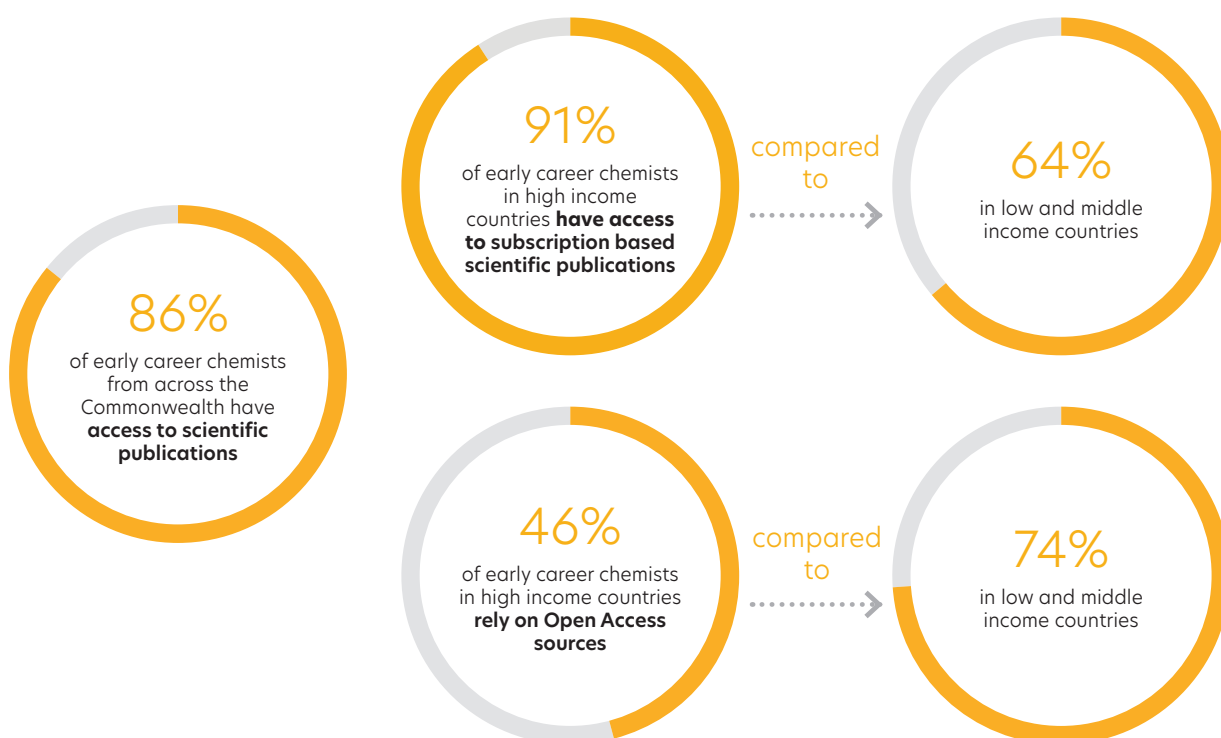
for clinical trials by a pharmaceutical company. His team also developed unique molecular tools and methods to detect and distinguish Alzheimer's from other neurodegenerative diseases. This technology is being translated through a start-up company to develop NIR and PET-based platforms for early diagnosis of the disease.

Early career chemists in low and middle income countries do not have the same access to scientific publications as their peers in high income countries.

Equal access to knowledge is fundamental if early career chemists are to have equal opportunity to succeed. Our survey suggests that this is not the case across the Commonwealth.

Although most early career chemists said they had access to scientific publications, those in low and middle income countries were less likely to have access to subscription based publications through their institution and more likely to rely on Open Access sources, such as ResearchGate and Scihub.

This is significant because a sizeable proportion of new research is still published behind a paywall⁵ although this is changing.



Some focus group participants said a lack of access to publications also makes it hard to get their research published, as it is difficult to write a comprehensive literature review. They also highlighted that Open Access article processing charges (APCs) can prevent them from publishing.

"*You want to write a paper, but to get it published internationally, the cost is too high."*

Early career chemist, middle income country

These results highlight the importance of Open Access and Open Science, with fee waivers for researchers whose institutions cannot cover APCs, to ensure equitable access to knowledge.

Schemes, such as Research4Life*, which offer scientists in low and middle income countries full access to journals from a wide range of publishers, go some way to addressing this challenge.

COVID-19 has brought additional challenges.

A number of focus group participants mentioned additional challenges brought by COVID-19. Some found it difficult to balance work and childcare while working from home, particularly when there was an expectation to be available for online meetings outside of working hours.

Not being able to use laboratory facilities or travel for collaborations also made it much harder to conduct research. This particularly impacted people on short-term research fellowships, as they could not complete enough experiments during their funding period to publish a paper.

Some early career chemists in low and middle income countries also said a lack of reliable internet connectivity made it difficult to teach and attend meetings online.



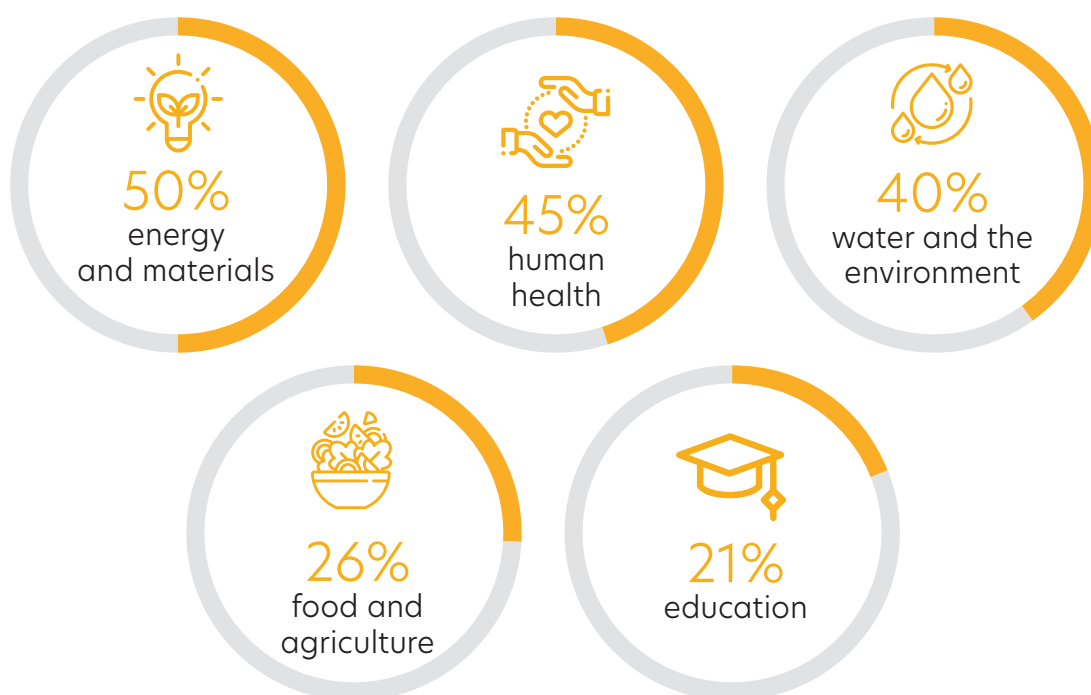
*Research4Life is a partnership between the WHO, FAO, UNEP, WIPO and over 180 publishers. See <https://www.research4life.org/> for more detail.

Research

Chemistry is essential for achieving the UN SDGs⁶. More than nine in ten early career chemists are working on research that is relevant to these goals. However funding and time for research are a significant challenge, particularly for chemists in low and middle income countries.

Early career chemists across the Commonwealth are engaged in research on a range of topics that are vital for a sustainable world, in particular energy and materials and human health.

% of early career chemists engaged in research that could apply to:



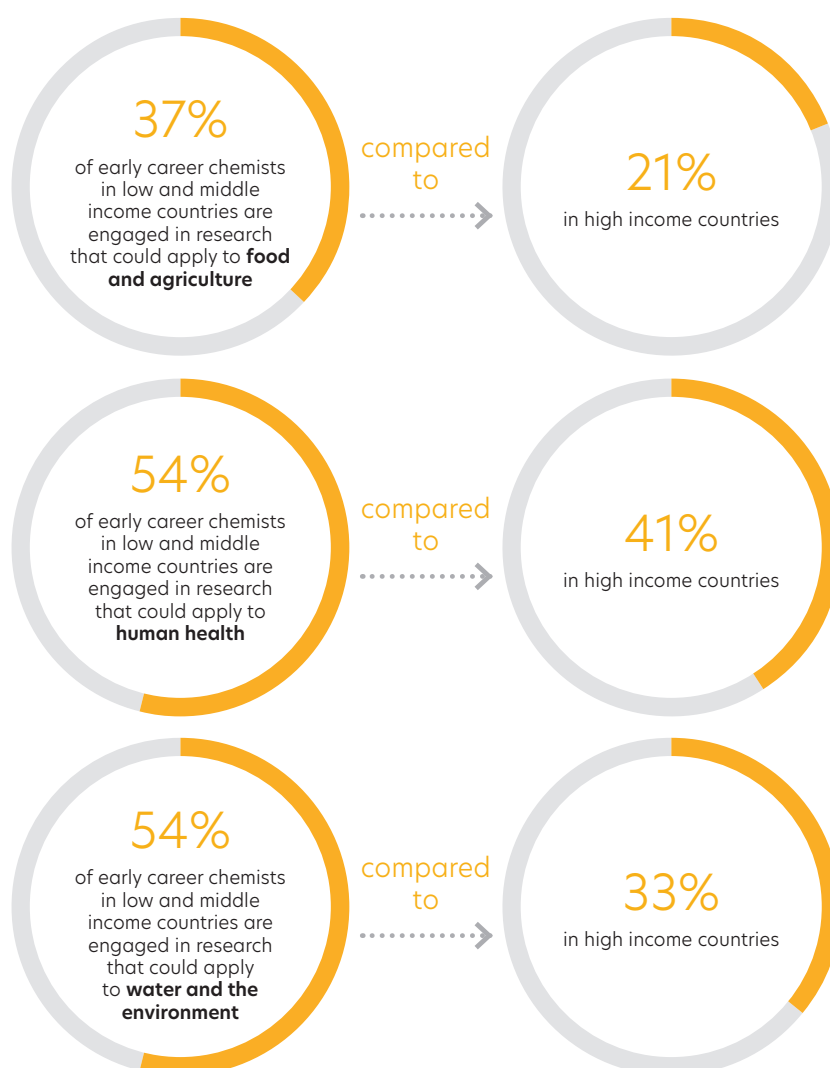
Spotlight on Impact



Purifying drinking water using nanofibers from the moringa plant

Ngonye Keroletswe is an early career chemist at the Botswana Institute for Technology Research and Innovation. She is part of an international collaboration that is researching how to solve the widespread problem of mercury contaminated drinking water. The team developed a natural carboxycellulose nanofiber from raw moringa plants using the nitro-oxidation method and showed it can be used to filter mercury out of water.

Commonwealth early career chemists in low and middle income countries are more likely than those in high income countries to research topics related to food and agriculture, human health, and water and the environment.



This may partly reflect the different research priorities for different countries, with low and middle income countries facing more pressing challenges related to areas like health, food security and access to clean water.



Spotlight on Impact



Nanotechnology for sustainable cancer diagnosis and research

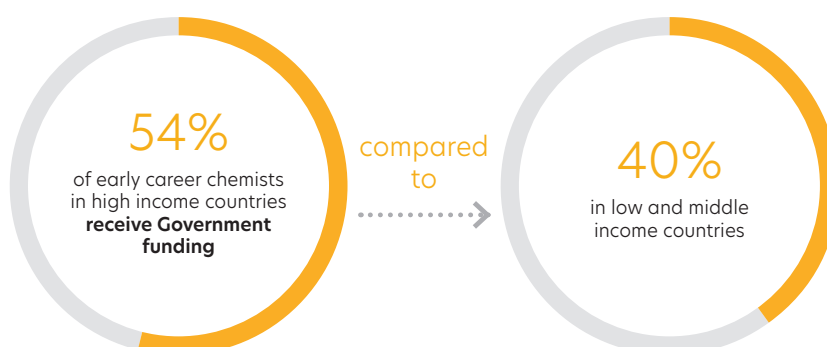
Siu Yee New is an early career chemist and Associate Professor at the School of Pharmacy at the University of Nottingham Malaysia. She is leading a research group that is developing biosensors using colorimetric gold nanoparticles and fluorogenic metal nanoclusters for a variety of bio-applications. This includes detecting telomerase activity, which is used both in diagnosing cancers and in searching for anti-cancer drugs.

Nanotechnology is a sustainable solution because it enables researchers to 'do more with less', reducing the materials used as well as waste.

Funding for research across the Commonwealth is largely dependent on criteria such as the area of research or its potential application, but many early career chemists feel unsure of how to apply for funding.

Nearly four in five (79%) of early career chemists said access to funding in their country or region was dependent on factors such as their area of research, or whether they were doing applied or fundamental science. However, less than half (41%) felt they had clear guidance on how to apply for funding. This was similar for chemists in low and middle income countries and those in high income countries.

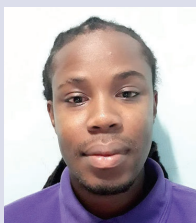
Early career chemists in low and middle income countries are less likely to receive Government funding and more likely to rely on private funding than those in high income countries.



This is unsurprising given that funding for research is generally higher in high income countries³ including Government funding⁴.



Spotlight on **Impact**



Biofuels for cleaner, greener energy

Nikolai Holder is an early career biochemist based at the University of the West Indies. His research focuses on the production of biofuels such as biomethane, ethanol and biodiesel. Using microorganisms – mainly bacteria – Nikolai and his team have been investigating different biochemical reactions, such as the biochemical conversion of biomass to fuel and the rapid production of various enzymes to carry out chemical and biochemical syntheses.

Nikolai discovered that grass clippings, which he collected from around the campus, are a particularly effective bio-organic substrate. He constructed a semi-industrialised anaerobic digester system and fed the clippings into it to produce biogas. The biogas the team produces now powers six research labs on campus, as well as the teaching lab and prep room.

Such developments towards cleaner, greener energy production are important for a region that has been largely dependent on fossil fuels and is particularly vulnerable to the impacts of climate change.

Lack of research funding in general is a major challenge for early career chemists, particularly in low and middle income countries.

Participants from across the Commonwealth said it can be hard to get funding at the earlier stages of their career, as funders appear to favour more established names with existing track records.

"There are certain funding schemes available to early career chemists, but in general funding schemes look for [well established] names."



Early career chemist, middle income country

Research funding is a particular challenge for early career chemists in low and middle income countries. This is in addition to the challenges they face in accessing equipment and consumables.

A recent survey of early career researchers in the Global South by the International Network for Advancing Science and Policy (INASP) found that insufficient access to research funding was an issue for nearly all respondents, and that it is particularly difficult for less experienced researchers to get the funding that they need for their research⁷.

Small grants can make a big difference.

Some participants highlighted how even small amounts of funding can make a big difference to their ability to conduct research and therefore get published. They suggested it would be beneficial for funding bodies to split funding into smaller amounts, in order to offer a larger number of grants and give less established researchers a chance to get started.

"Don't underestimate small grants... They can be really, really useful."



Early career chemist, high income country

A lack of time for research is also a major barrier for early career chemists in low and middle income countries.

Although there was considerable variation across the Commonwealth, broadly speaking early career chemists in high income countries reported spending more time on research as part of their job than their peers in low and middle income countries.

Some early career chemists in low and middle income countries said that teaching takes up 80-90% of their time. This creates a significant challenge, as career progression and job security depend on publication records.

"The biggest challenge is managing time... There is so much that's thrown at you – service administration, teaching, marking and then research, looking for funding opportunities and writing grants."



Early career chemist, middle income country

Inappropriate institutional criteria can make it even harder to satisfy publishing requirements.

Some focus group participants said their institutions set inappropriate criteria when assessing publications as part of performance reviews, such as requirements to publish in journals considered to be more prestigious. This can be challenging for early career chemists, as such journals may be less likely to accept work from less established researchers.

In addition, the most relevant journal for an individual's area of research may not be on the approved list. While for researchers focused on developing products and technologies, publication may not be a relevant metric at all.

It is difficult to progress in research without a PhD.

A few focus group participants highlighted the fact that researchers cannot progress in their careers without a PhD, even if they have significant relevant experience.

This is particularly challenging when there are limited funded PhD opportunities available locally and an individual is not able to move abroad, for example due to family commitments.



"I had contacts for a collaboration for joint projects but I couldn't be the Principal Investigator because I don't have a PhD, although I have experience in research."

Early career chemist, low income country

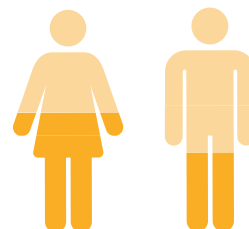


Inclusion and diversity

The evidence shows that diverse teams do better science⁸. Unfortunately, inequality and a lack of diversity is a major problem in the chemical sciences⁹, particularly when it comes to gender¹⁰. Our survey results show this is also the case in the Commonwealth.

Women are more likely than men to be held back by prejudice, family commitments and working hours, although these also impact men.

Half of women who are early career chemists are negatively impacted at work by prejudice due to race, gender or disability, compared to one third of men.



Despite this, men were more likely to say they would be confident in identifying an act of discrimination in their workplace (76%) than women (62%). This may be because they are less likely to have experienced discrimination directly¹¹.

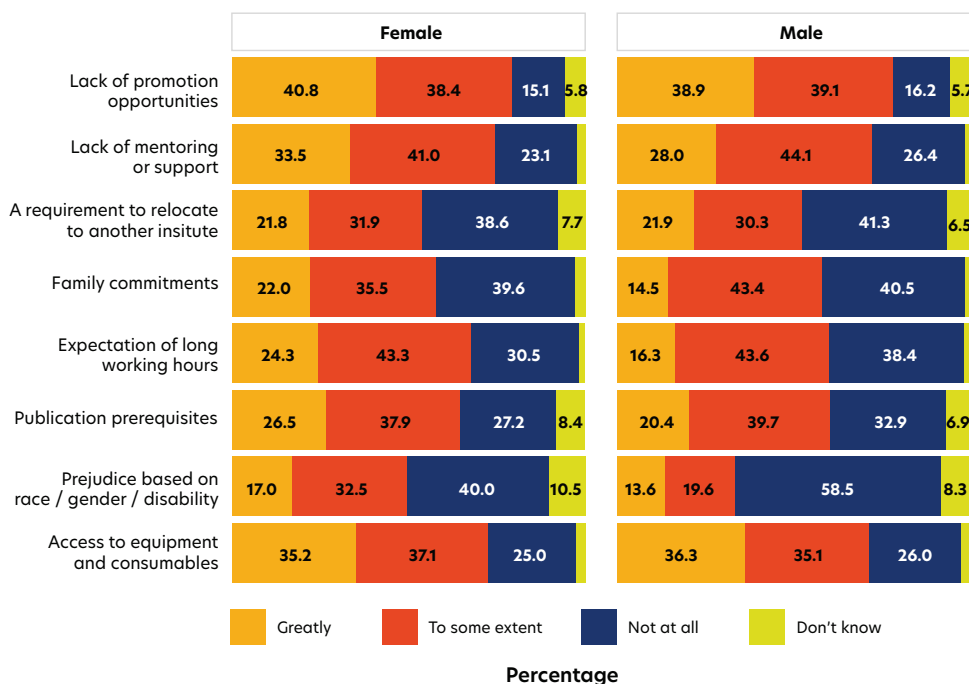
Women are also impacted more severely by challenges related to family commitments and working hours.

More than one in five women (22%) said family commitments negatively impacted their work to a great extent compared to one in six men (15%). Nearly one in four women (24%) said the expectation to work long hours negatively impacted their work to a great extent compared to one in six men (16%).



These findings are in line with recent research by the Royal Society of Chemistry, which found that women working in the chemical sciences in the UK face discrimination and practical barriers such as limited opportunities for flexible or part-time working to accommodate family commitments¹⁰.

We asked to what extent do the following aspects negatively impact your work?



The culture of chemistry disproportionately disadvantages women.

In the focus groups, both men and women highlighted the difficulty of balancing high workloads with family and social commitments.



"I don't have children, however work takes up probably 90% of my time... it is a significant challenge to maintain relationships and friendships."

Early career chemist, middle income country

However, family commitments affect women more due to the need to take maternity leave and a higher burden of ongoing childcare. Many women described their frustration at seeing male colleagues progress more quickly due to not facing the same pressures.



"I have taken time off [to have children]... Sometimes you get discouraged if you compare yourself with your male colleagues who started at the same time, but they've obviously been able to progress much faster."

Early career chemist, low income country

This is compounded by the fact that, broadly speaking, the academic system disadvantages people who take career breaks, as candidates are judged on their most recent publication and grants.



"You're only as good as your last paper and your last grant. The entire system is against people taking career breaks, whether that be to have a family, go on sabbatical to learn some new skills or get another job for a while and come back."

Early career chemist, high income country

Both women and men also highlighted that many chemistry departments are dominated by men, particularly at senior levels. This means there are limited role models for women, and there can be a lack of understanding of the challenges they face.

Women continue to face discrimination, bullying and sexual harassment.

Some women also shared experiences of discrimination, bullying and sexual harassment, and even sexual assault at work. Many said their ideas were not sought or listened to as much as their male peers, particularly in settings where older male colleagues dominated.



"Sexual harassment is often widely known, rarely reported."

Early career chemist, high income country

While some women said that their institutions had robust systems in place to deal with such issues, others had reported serious incidents but found their complaints were not properly dealt with.

This is consistent with a recent investigation into the culture of research more widely, which found that women were more likely to have experienced discrimination or witnessed it than men, most commonly on the basis of gender, and that women were less likely than men to believe their concerns relating to these issues would be acted on appropriately¹¹.

A lack of diversity and inclusion also creates challenges for early career chemists from under-represented cultural and ethnic groups.

Early career chemists from under-represented groups, including minority ethnic groups, can struggle with a range of challenges such as a lack of representation, peers with shared experiences, and a culture of chemistry that it is not inclusive of cultural beliefs and language barriers.

This can lead people to feel they are not able to be open about their background, with adverse effects on their mental health. Some early career chemists also reported experiences of racism.



"In the beginning I didn't actually talk about my [cultural] heritage, because of this fear of being treated differently... You just sort of feel isolated and it can be a real drain on your mental health."

Early career chemist, high income country



"Racism in my country hinders the progress of promotion."

Early career chemist, middle income country

Early career chemists also face bias in the publication process.

Some early career chemists said they had experienced or witnessed bias within the publication process. For example, papers submitted by well-known researchers appear more likely to be accepted, as do those submitted by male Principal Investigators.

Some participants also felt that reviewers may be influenced by the research reputation of the institution or country that the researcher is based in.



"I frequently experience prejudice based on which institution you work for. Higher Education in [my country] is extremely hierarchical..."

Early career chemist, high income country

It was suggested training for Boards of Editors on Equality, Inclusion and Diversity or blind peer review might help to address some of these issues.

More broadly, there is evidence that the competitive nature of research leads to an unsupportive culture.

Research involving researchers from around the world working in a range of disciplines, including the sciences, found that 78% of researchers think high levels of competition have created unkind and aggressive conditions, while nearly two thirds (61%) have witnessed bullying and more than two in five (43%) have experienced it themselves, and just over half (53%) have sought, or have wanted to seek, professional help for depression or anxiety¹¹.

Supportive colleagues, policies and institutions can create a more inclusive and equitable environment, particularly for those with family commitments.

A number of participants highlighted the positive impact that senior colleagues can have on creating a more collaborative and inclusive culture. For example, encouraging their students to share ideas, or creating research teams that share resources and publication credits.

"In my institution we are allowed to air out different views and dialogue on them. Individuals from various backgrounds and races are employed to help diversify the process of solving a problem."

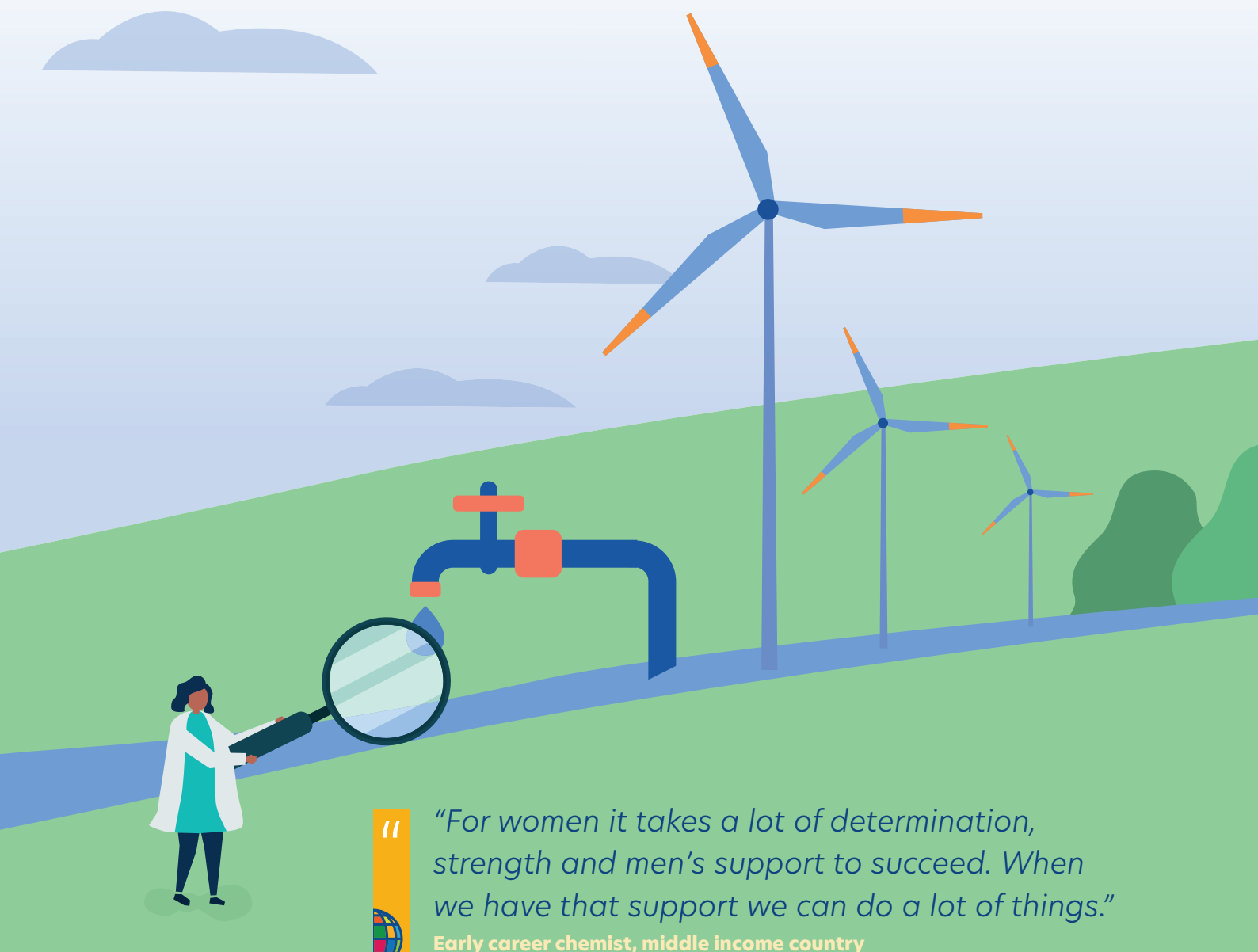


Early career chemist, middle income country

Some women gave examples of how male colleagues had been supportive, such as taking on some of their teaching load when they had young children. Men also said they appreciated it when colleagues were flexible so they could attend to family duties.

More generally, women highlighted the positive impact of having a supportive line manager and policies that enable them to balance work and family, for example making adaptations to laboratory work so they can continue during pregnancy. They also spoke about their determination to remove barriers for the next generation, for example by advocating for child care facilities on campus.

Some women also said that they were more likely to apply for grants when it was explicitly stated that female applicants were encouraged or they were for women only, as this made them less worried about career breaks being held against them.



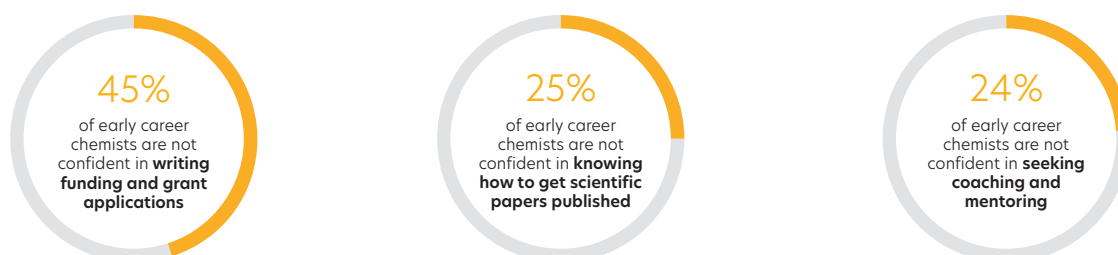
"For women it takes a lot of determination, strength and men's support to succeed. When we have that support we can do a lot of things."

Early career chemist, middle income country

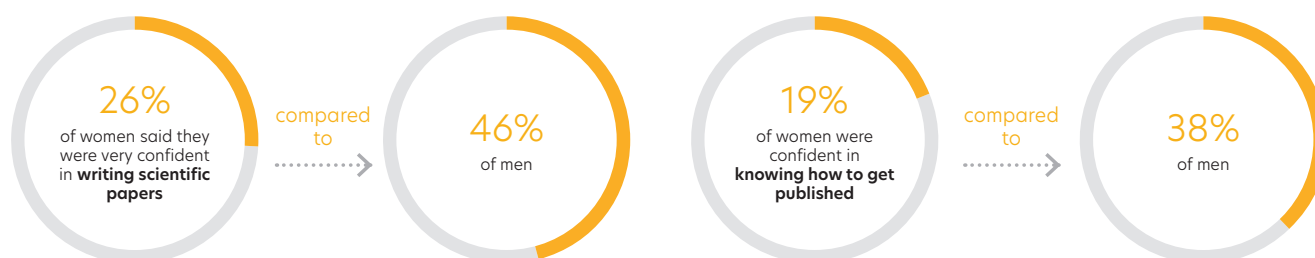
Non-technical skills

Scientists need a range of non-technical skills to succeed, such as applying for funding, teaching and publishing their work. Early career chemists are confident in some of these areas but need support in others.

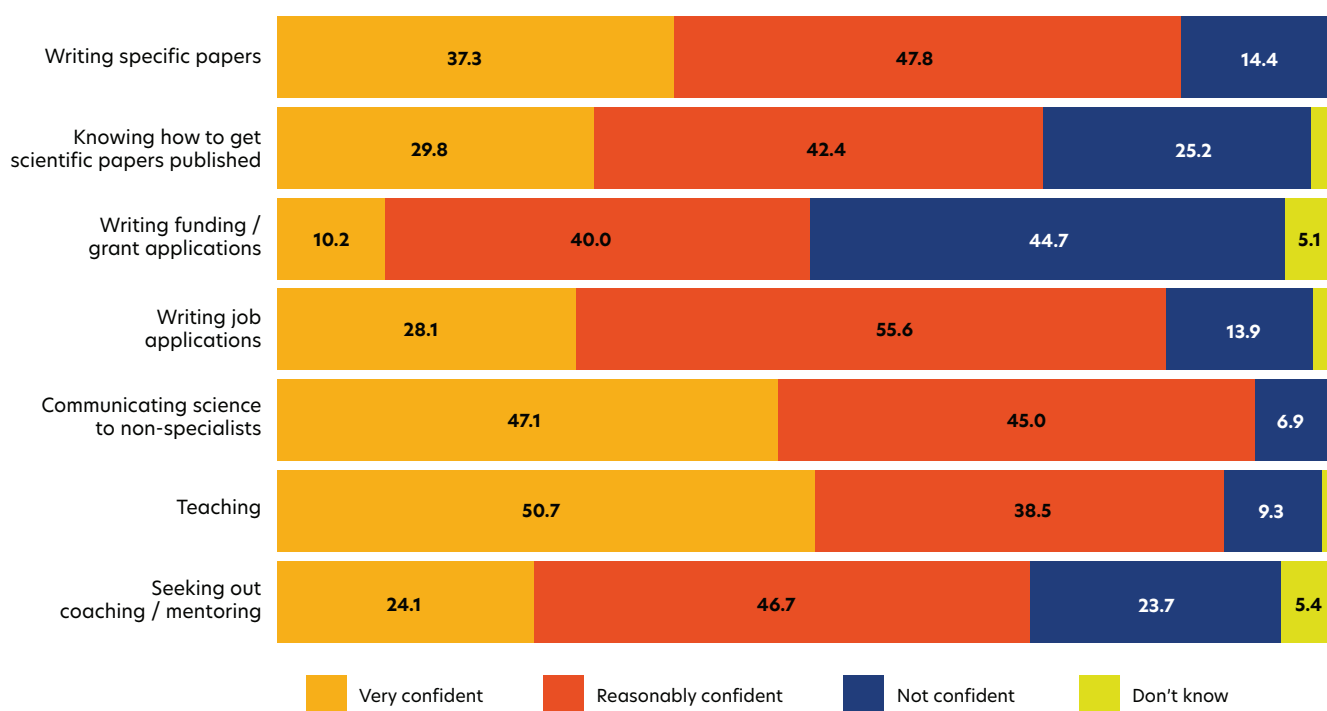
Early career chemists need more support in writing funding and grant applications, getting scientific papers published, and seeking out coaching and mentoring.



Women early career chemists are less confident in their non-technical skills than men, particularly when it comes to writing scientific papers and knowing how to get published.

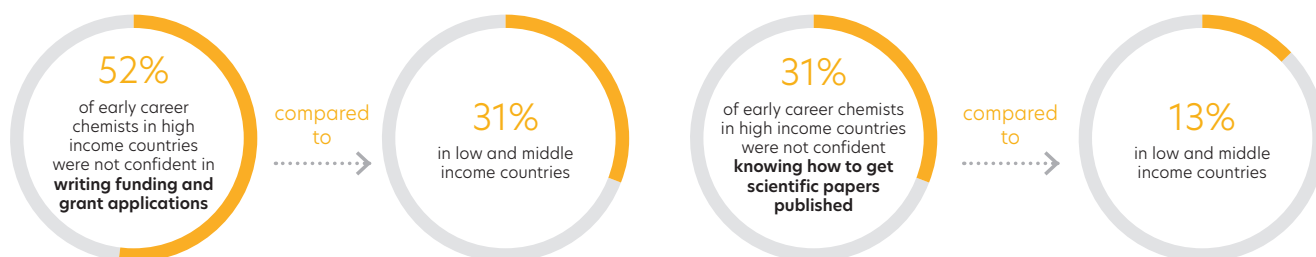


We asked to what extent do you feel confident in the following activities?



Percentage

Early career chemists in low and middle income countries are more confident than those in high income countries when it comes to applying for funding and publishing their work.



Confidence in teaching and writing job applications is high across the Commonwealth.



Providing training on non-technical skills early on is key.

A number of participants had received training on writing funding applications during their PhD. They stressed that this was hugely beneficial and prepared them well for post-doctoral positions when they had to apply for their own funding. Other participants said training on skills such as teaching was invaluable.



"When I was in grad school we were tasked with writing grants... So going onto a new university I already knew how to put a grant together."

Early career chemist, middle income country



"Our university runs a compulsory short course for new appointments to prepare them for all aspects of teaching, including assessment. This was invaluable."

Early career chemist, middle income country



Spotlight on **Impact**



Putting sustainability at the heart of chemistry education

Amanda Bongers is an early career chemist and Assistant Professor of Chemistry Education at Queen's University in Canada. She is leading a research project exploring how sustainability is incorporated into general and organic chemistry education, and whether embedding sustainability into the curriculum improves students' attitudes to the topic. Her team are drawing on tools from educational research, cognitive psychology and neuroscience to study learning in science – and ultimately improve the way chemistry is taught.



Collaboration across the Commonwealth

Collaboration can accelerate progress for individuals and for science. While many early career chemists are already working with colleagues in other Commonwealth countries, a range of factors can get in the way.

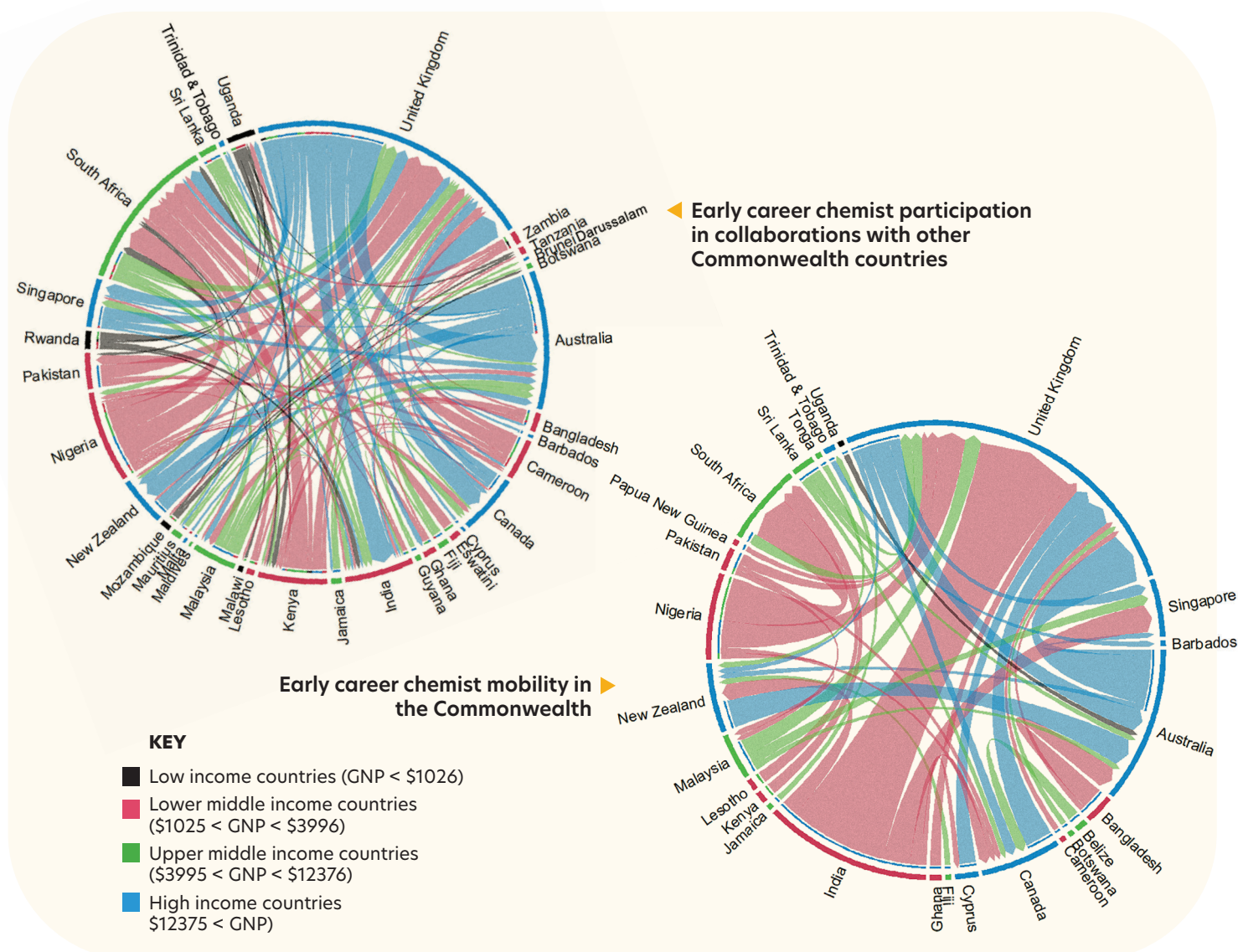
There is considerable collaboration and movement of early career chemists between different Commonwealth countries. However, there is an opportunity to increase collaboration between regions and between high and low and middle income countries.

We asked early career chemists about whether they were taking part in research collaborations with any other Commonwealth countries or had moved countries to take part in research. We identified some trends based on the information they shared.

It appears that early career chemists in India are collaborating and moving widely across the Commonwealth. In Africa, early career chemists appear to largely move and collaborate within the continent, with South Africa being a strong research anchor. South Africa and Nigeria also have strong links to the UK.

It was also notable that early career chemists in high income countries are more likely to collaborate with and move to other high income countries.

It appears there is an opportunity for greater collaboration between regions and in particular for chemists in high income countries to work more closely with colleagues in low and middle income countries, for example on key sustainability challenges.



Funding for travel and a lack of networking opportunities are the biggest barriers to collaboration across the Commonwealth.

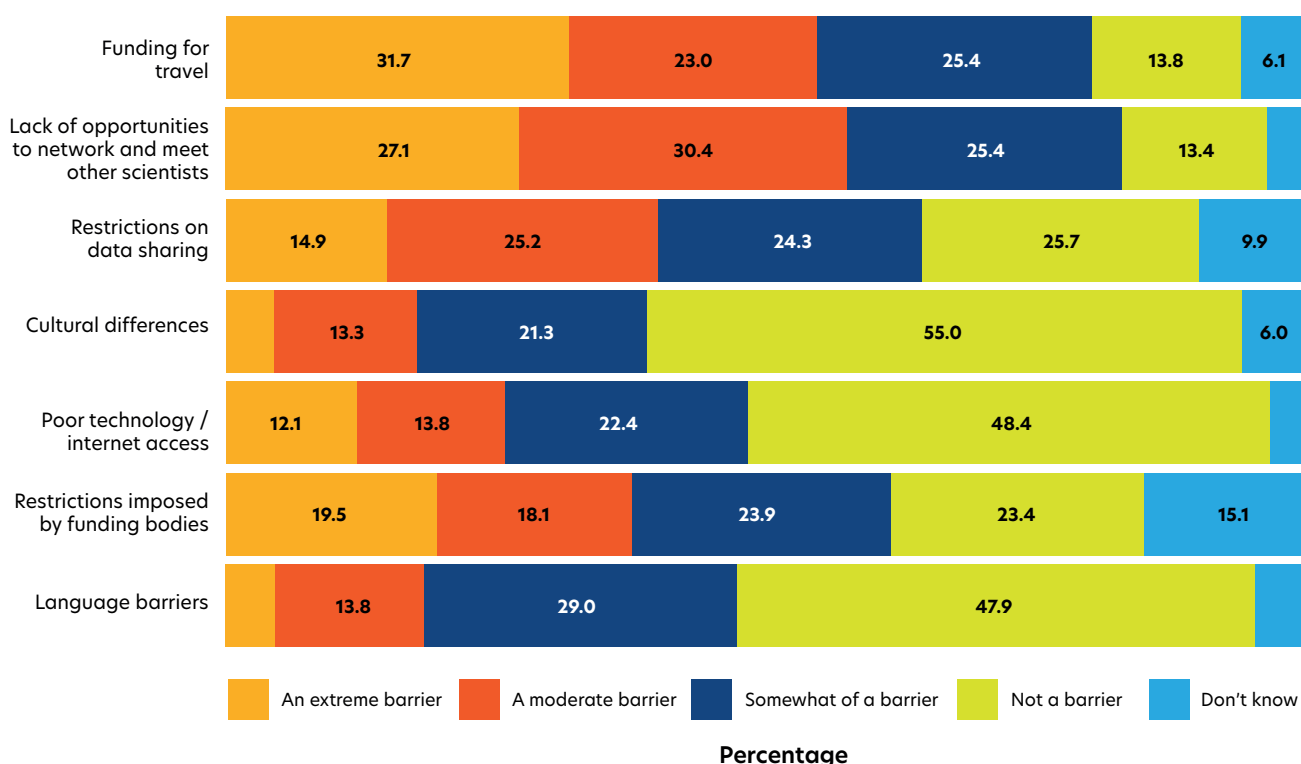
To develop collaborations, scientists need the chance to build relationships. Spending time together in person is important, despite the benefits of online meetings. This can be particularly the case in forging partnerships between chemists in different countries where cultural barriers are more likely to exist with the need to overcome stereotypes or preconceptions.

At the moment, early career chemists across the Commonwealth do not have enough opportunities to develop their networks or enough funding to travel to meet with colleagues in other institutions and countries.

Four in five (80%) said funding for travel was a barrier to collaboration, four in five (83%) said a lack of networking opportunities was a barrier, and more than two thirds (70%) said that they do not belong to an early career chemist network.

Previous research has also identified lack of funding as one of the most significant barriers to international collaboration for scientists¹².

We asked to what extent are the following items barriers when collaborating with other scientists?

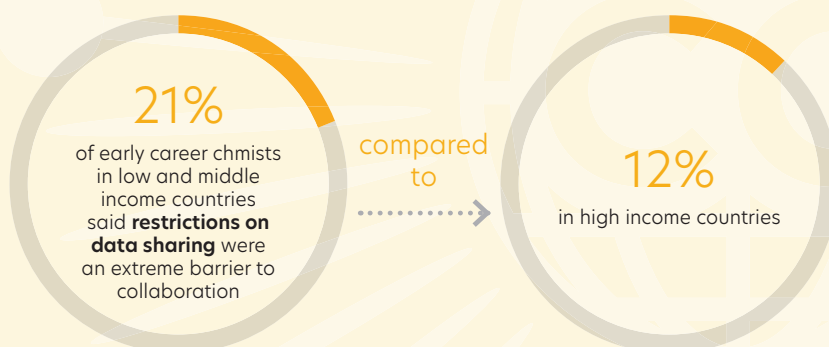
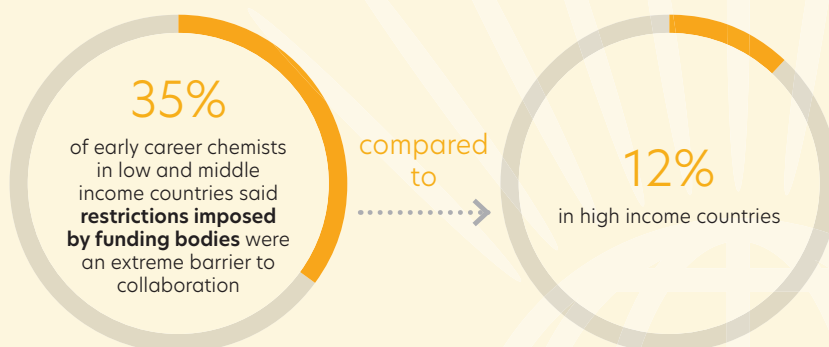
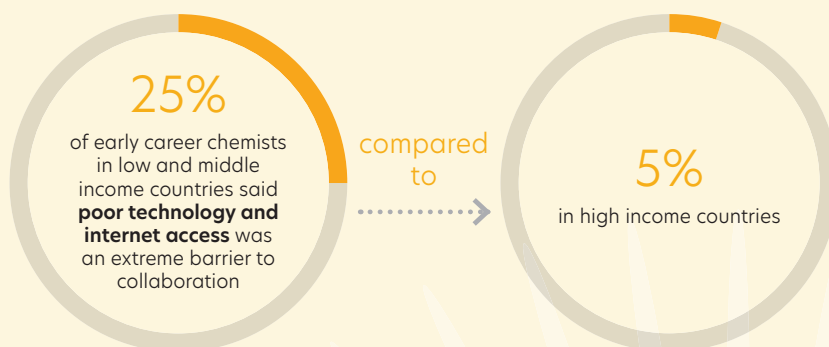
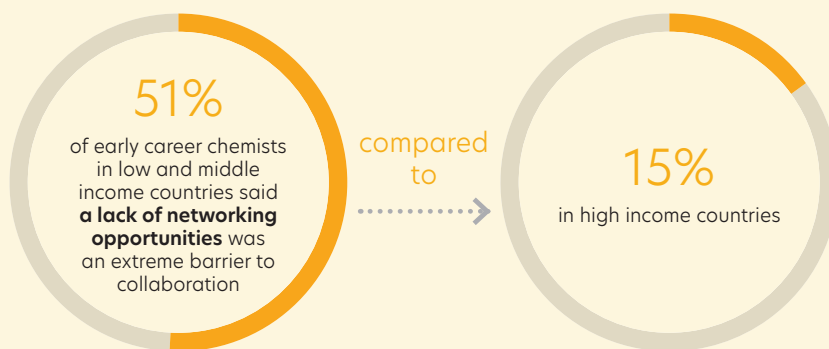
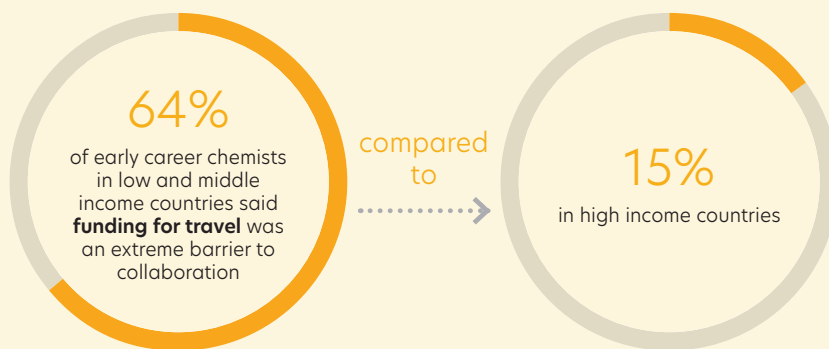


Early career chemists in low and middle income countries face much bigger barriers to collaboration than their peers in high income countries.

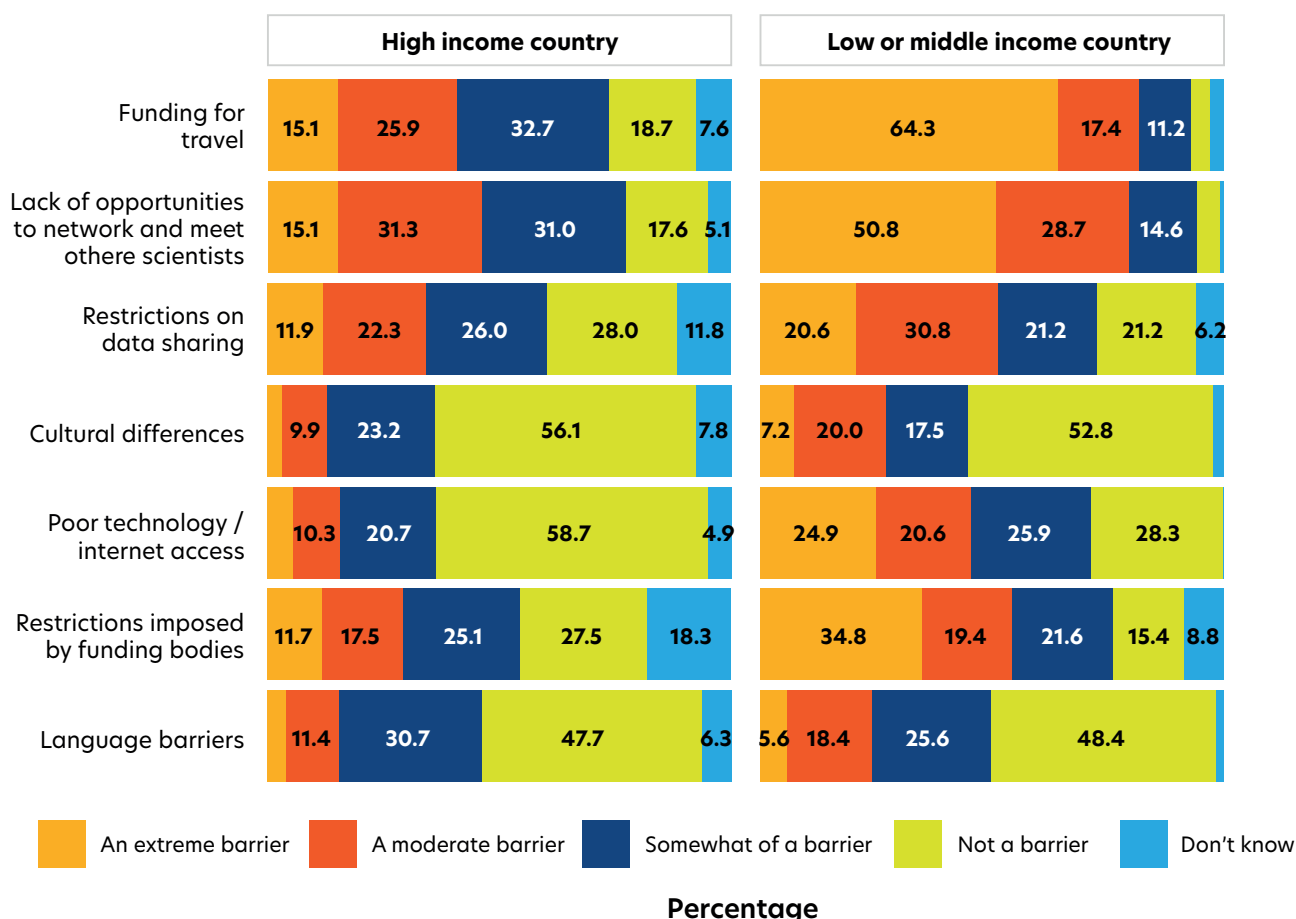
Early career chemists across the Commonwealth face barriers to collaboration such as funding for travel, a lack of opportunities to network, restrictions on data sharing, poor technology and internet access, and restrictions imposed by funding bodies.

However, these factors have a bigger impact on early career chemists in low and middle income countries. For example, two in three early career chemists from low and middle income countries said funding for travel was an extreme barrier to collaboration, compared to just one in six of those in high income countries.

Similarly, more than half of early career chemists in low and middle income countries said a lack of networking opportunities was an extreme barrier to collaboration, compared to one in six of those in high income countries.



We asked to what extent are the following items barriers when collaborating with other scientists?



This is consistent with the findings of a recent survey by INASP of early career scientific researchers in the Global South⁷. Nearly nine in ten respondents (87%) thought that collaborating outside of their institution was vitally important.

However, many felt that opportunities, funding, and support from donors, decision-makers and research institutions can be limited for researchers from the Global South.

This can lead to inequitable partnerships, with the balance of power often tipped towards northern or more senior peers. In INASP's survey, early career researchers from the Global South also said poor institutional support and a lack of time and access to partners were obstacles to collaboration.

Developing networks is vital for enabling collaboration.

Focus group participants emphasised the importance of networking opportunities for developing collaborations. Some said they had appreciated the move to online events during COVID-19 as this made it less expensive to attend which increased access, while others found it more difficult to make connections at online events than in-person ones.

Early career chemists highlighted a number of roles they would like a formal network to play, including sharing knowledge, skills and experience, facilitating data and equipment sharing between institutions, and sharing information about funding and job opportunities.

"If we can get networks built up so we can collaborate with each other, share the resources that we have, share the knowledge that we have, that will definitely help."



Early career chemist, middle income country

Some participants also spoke about the need to develop networks beyond academic chemistry, with industry, governmental organisations and colleagues in the social sciences, to help translate research into real-world impact.

"How do you achieve the sustainable development goals when you don't apply research work or data into policy?"



Early career chemist, low income country



Recommendations and commitments



**Commonwealth
Chemistry**
Federation of Chemical Sciences Societies

Our key recommendations

For The Commonwealth

1. Use its convening power to encourage greater scientific collaboration across the Commonwealth, for example by convening Commonwealth ministers of science and technology, funding agencies and other key stakeholders.
2. Enhance support for early career scientists through its existing capacity building programmes.
3. Engage with member countries to promote inclusion and diversity more broadly in science, building on its efforts to promote the inclusion of women in Science, Technology, Engineering and Maths (STEM) programmes.

For funders of research

1. Create or increase funding streams and grants specifically for early career chemists. This is critical for the retention of chemical scientists in the profession, and therefore the sustainability of chemical skills.
2. Provide more support for early career chemists to apply for grants and funding, for example offering advice and clear guidelines and giving more feedback on applications.
3. Collect data on inclusion and diversity in teams and institutions receiving funding and consider inclusion and diversity criteria when assessing applications.
4. Make more funding available for equipment (including maintenance) and consumables, particularly in low and middle income countries where this is a significant constraint.
5. Make more funding available for early career chemists to travel for research collaborations. This would have a particularly positive impact on those in low and middle income countries, where a lack of funding for travel is an even bigger barrier.

For universities and chemical sciences employers

1. Increase training in non-technical skills for chemists at the early stages of their careers, in particular skills related to securing funding and getting published.
2. Consider developing schemes to facilitate equipment sharing between institutions.
3. Promote working practices that enable early career chemists to balance family commitments with work, for example flexible working. This would help more women to thrive in the profession, it would also benefit men.
4. Develop coaching and mentoring programmes for early career chemists.
5. Increase job security for early career chemists by offering longer term contracts.
6. Collect information on chemical sciences inclusion and diversity in their organisations and take action to achieve equality.

Our key commitments

We will empower early career chemists to build their networks by:

- Setting up a Commonwealth Chemistry Early Career Network.
- Holding online and in-person events including congresses, poster events, workshops and webinars.
- Supporting the development of new and existing national chemical societies, which play a key role in connecting chemists at a national level at all stages of their careers.

We will support early career chemists to develop crucial non-technical skills by:

- Partnering with other organisations to increase access to professional development opportunities, training courses and careers guidance.

We will champion equality in chemistry in all its forms by:

- Empowering our national chemical society members and associate members to champion inclusion and diversity in their local chemistry communities.
- Facilitating the sharing of good practice between organisations in the chemical sciences.
- Celebrating International Women's Day and Commonwealth Day with a range of activities, including running events related to their themes.

We will facilitate knowledge sharing between early career chemists across the Commonwealth by:

- Providing free online access to Chemistry World magazine for members of every chemical society that has joined Commonwealth Chemistry.
- Engaging with policy makers and funders to increase knowledge sharing, including equal access to scientific publications for early career chemists.

Appendix: Methodology



**Commonwealth
Chemistry**
Federation of Chemical Sciences Societies

Overview

This report is based on the results of a survey and four focus groups. The survey was conducted online from September to November 2020, with the participation of early career chemists from 38 of the 54 Commonwealth countries.

It consisted of 20 questions broken down into four main sections: career progression, training and funding, working environment, and collaboration and networks. We also included a question asking participants what kind of support they would like to see Commonwealth Chemistry provide to early career chemists and the wider Commonwealth chemistry community. The focus groups took place virtually in September 2021. The aim was to better understand some of the key themes that emerged from the survey.

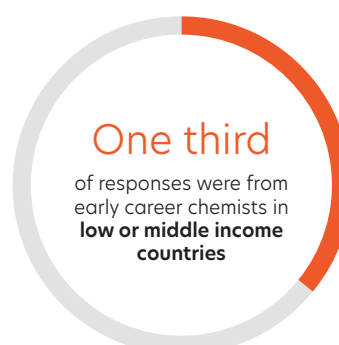
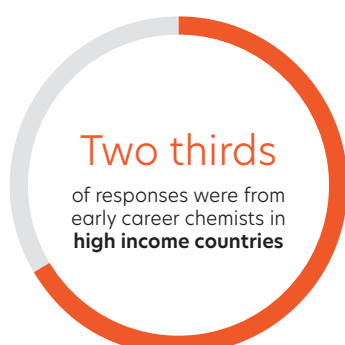
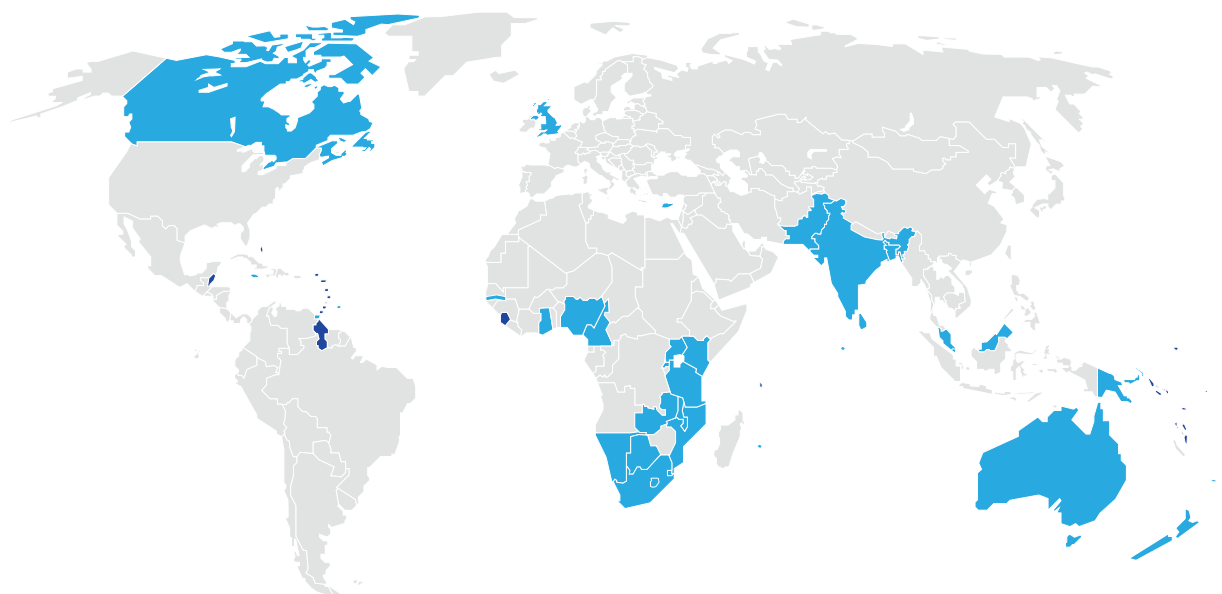
Participants were either based in low, middle or high income Commonwealth countries or were Commonwealth nationals currently living outside the Commonwealth. Participants who did not meet these criteria were excluded from the analysis.

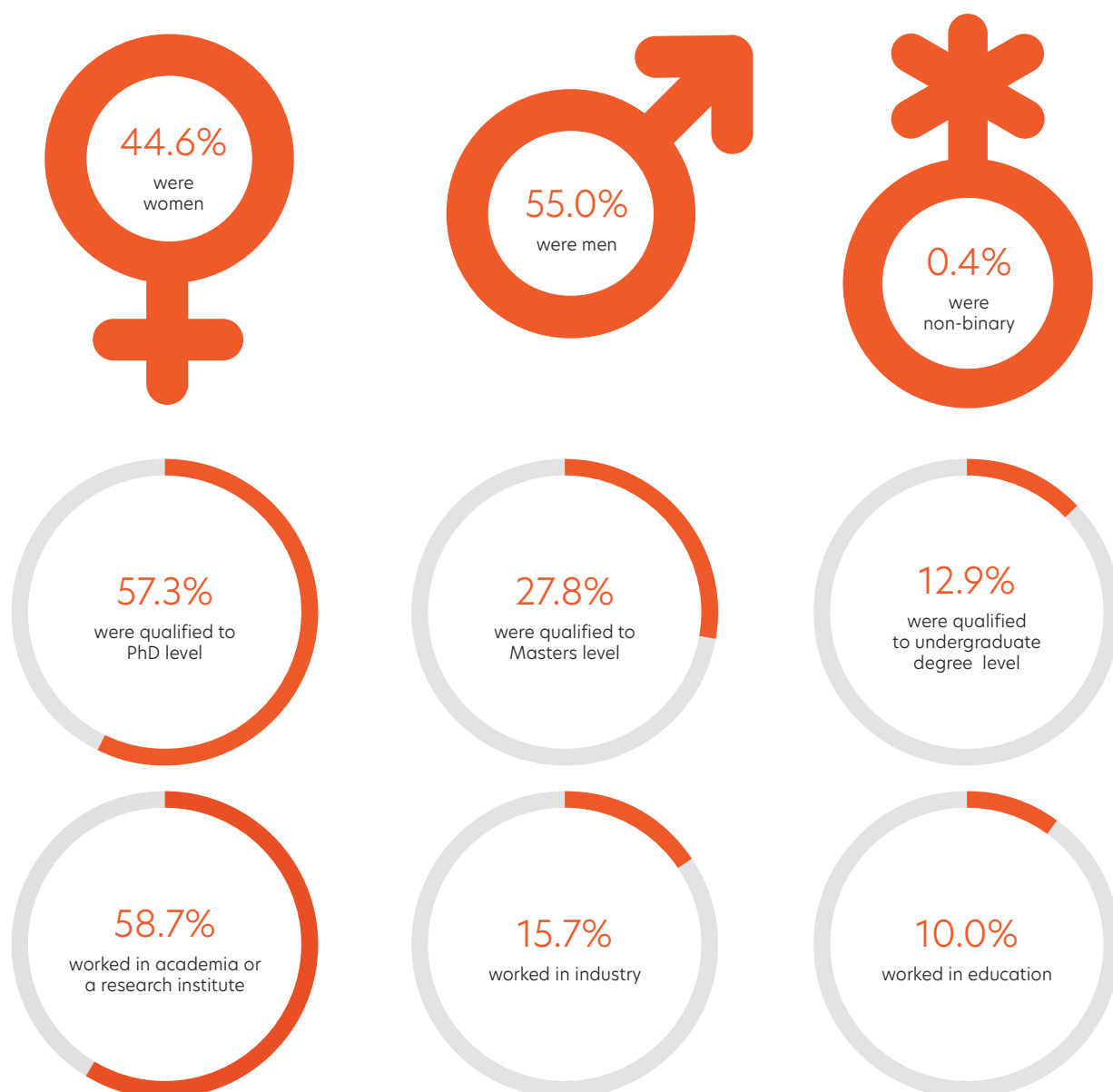
Participants

For the purposes of this research, an early career chemist was defined as anybody who was within the first 10 years of their career after completing their most recent chemistry-related qualification, (excluding any career breaks).

The Commonwealth Countries and who we spoke to

Antigua and Barbuda, **Australia**, **Bangladesh**, **Barbados**, Belize, **Botswana**, **Brunei Darussalam**, **Cameroon**, **Canada**, **Cyprus**, Dominica, **Eswatini**, **Fiji**, **Ghana**, Grenada, Guyana, **India**, **Jamaica**, **Kenya**, Kiribati, **Lesotho**, **Malawi**, **Malaysia**, **Maldives**, **Malta**, **Mauritius**, **Mozambique**, **Namibia**, Nauru, **New Zealand**, **Nigeria**, **Pakistan**, **Papua New Guinea**, **Rwanda**, Saint Lucia, Samoa, Seychelles, Sierra Leone, **Singapore**, Solomon Islands, **South Africa**, **Sri Lanka**, St Kitts and Nevis, St Vincent and the Grenadines, **Tanzania**, The Bahamas, **The Gambia**, **Tonga**, **Trinidad and Tobago**, Tuvalu, **Uganda**, **United Kingdom**, Vanuatu, **Zambia**.





How we analysed the data

In analysing the survey data, we looked at whether the experiences of different groups varied. This included exploring whether early career chemists in low and middle income countries face different challenges to their peers in high income countries.

We grouped low and middle income countries together for this purpose to avoid overly reducing the sample size, given the lower response numbers for chemists from these countries.

We also looked at whether there were differences between responses from men and women as previous research has shown that women in scientific careers may face additional barriers related to their gender.

Due to rounding some of the totals on the graphs may not be exactly 100%. Likewise percentages have been omitted where they are less than 5%.

The qualitative data from the survey free text responses and focus groups were also analysed to identify key themes, which were included in the discussion of the survey results.

Limitations

A higher proportion of respondents came from high income countries than from middle and low income countries. This reflects the greater number of practising chemists in high income countries (proportional to the population), as well as higher barriers for participants in low and middle income countries in accessing the survey such as internet infrastructure. In addition, many low or middle income countries do not have a chemical society which means there are less well established networks by which to contact them.

References

1. Christian, Katherine et al. A survey of early-career researchers in Australia. eLife vol. 10 e60613. 11 Jan. 2021, doi:10.7554/eLife.60613
2. Woolston, C. Graduate survey: A love-hurt relationship. Nature 550, 549–552 (2017). <https://doi.org/10.1038/nj7677-549a>
3. Scienceogram UK, International Comparisons: <https://scienceogram.org/in-depth/international-comparisons/>
4. How Much Does Your Country Invest in R&D? UNESCO Institute for Statistics. <http://uis.unesco.org/apps/visualisations/research-and-development-spending/>
5. Piwowar, Heather et al. The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. PeerJ. 2018; 6:e4375. doi:10.7717/peerj.4375
6. UN SDGs: How can Sustainable Chemistry Contribute? RELX Sustainable Development Goals (SDGs) Resource Centre. <https://sdgresources.relx.com/special-issues/un-sdgs-how-can-sustainable-chemistry-contribute>.
7. INASP Voice of Early Career Researchers 2020: A study of research culture, researcher perceptions of their work and the research environment in the Global South. <https://www.inasp.info/voice-ECRs-2020> <https://www.inasp.info/voice-ECRs-2020>
8. Freeman, R. & Huang, W. Collaborating with People Like Me: Ethnic Coauthorship within the United States. Journal of Labor Economics 2015 33:S1, S289-S318
9. Diversity landscape of the chemical sciences, Royal Society of Chemistry, 2018. rsc.org/globalassets/02-about-us/our-strategy/inclusion-diversity/cm-044-17_a4-diversity-landscape-of-the-chemical-sciences-report_web-2.pdf
10. Breaking the Barriers: Women's progression and retention in the chemical sciences. Royal Society of Chemistry, 2019. <https://www.rsc.org/new-perspectives/talent/breaking-the-barriers/>
11. What researchers think about the culture they work in. Wellcome Trust. <https://wellcome.org/reports/what-researchers-think-about-research-culture>
12. Matthews, Kirsten R.W. et al. International scientific collaborative activities and barriers to them in eight societies, Accountability in Research, 2020, 27:8, 477-495, DOI: 10.1080/08989621.2020.1774373





Commonwealth Chemistry

Federation of Chemical Sciences Societies

commonwealthchemistry.org

