

scientists live within the context of extended families with additional responsibilities of caring for elderly relatives. 24 (57%) of 42 female respondents reported dependent relatives requiring care and spent a median 10–20 h per week on caring duties and a further 10–20 h per week on other domestic duties. These duties might have an effect on networking possibilities and travel. 15 (83%) of 18 female faculty members reported difficulty attending out-of-hours events or work-related travel sometimes or often, compared with 12 (60%) of 20 men. 21 (50%) of 42 women said that caring responsibilities had affected decisions regarding career-related long-term travel.

Flexible ways of working were considered advantageous, and 30 (71%) of 42 female scientists reported they would like to work from home. Nevertheless, challenges to working from home such as lack of space and noisy environments were noted.

To address these issues, we have implemented specific initiatives with strong institutional backing—namely, grant writing and leadership training tailored to our setting, and active identification and support of female scientists eligible for promotions. Enhanced mentorship was identified as desirable by 15 (83%) of 18 female faculty staff; therefore, we are designing a career-guidance programme suitable for local and international staff and inviting prominent female scientists to run workshops, creating a platform for potential role models. We will assess the effect of these initiatives through qualitative and quantitative evaluation.

However, substantial challenges remain, particularly concerning career mobility—hitherto seen as necessary for scientific career progression in an international environment. Funding bodies are beginning to recognise these issues, but they are yet to provide the substantial levels of support and innovative leadership needed to overcome them.

We declare no competing interests. This work was funded by the Wellcome Trust: major overseas program funding 106680/B/14/Z, intermediate fellowship 206724/Z/17/Z, and career-reentry fellowship 107367/Z/15/Z. We thank Nguyen Thi Hong Phuc, Katrina Lawson, Le Phuong Chi, Ho Van Hien, and Sarah Barton, from the Oxford University Clinical Research Unit, for data retrieval and operational support. EK and CLT contributed equally.

Ngo Thi Hoa, Nguyen Thy Thuong Thuong, Hannah E Clapham, Tran Thi Anh Thu, Evelyne Kestelyn, *C Louise Thwaites lthwaites@oucru.org

Oxford University Clinical Research Unit, Hospital for Tropical Diseases, Ho Chi Minh City, Vietnam (NTH, NTHH, HEC, TTA, EK, CLT); and Centre for Tropical Medicine and Global Health, University of Oxford, Nuffield Department of Medicine Research Building, Headington, Oxford OX3 7FZ, UK (HEC, EK, CLT)

- Walsh MN. Women as leaders in cardiovascular medicine. *Clin Cardiol* 2018; **41**: 269–73.
- Moss-Racusin CA, van der Toorn J, Dovidio JF, Brescoll VL, Graham MJ, Handelsman J. A “scientific diversity” intervention to reduce gender bias in a sample of life scientists. *CBE Life Sci Educ* 2016; **15**: pii: ar29.
- Valentova JV, Otta E, Silva ML, McElligott AG. Underrepresentation of women in the senior levels of Brazilian science. *PeerJ* 2017; **5**: e4000.
- Halpaap B, Vahedi M, Certain E, et al. Tracking the career development of scientists in low- and middle-income countries trained through TDR’s research capacity strengthening programmes: learning from monitoring and impact evaluation. *PLoS Negl Trop Dis* 2017; **11**: e0006112.
- Leke RG, Nolna SK. Health research: mentoring female scientists in Africa. *Nature* 2016; **536**: 30.
- Nicholson E. Accounting for career breaks. *Science* 2015; **348**: 830.
- Staff J, Mortimer JT. Explaining the motherhood wage penalty during the early occupational career. *Demography* 2012; **49**: 1–21.

Australia’s strategy to achieve gender equality in STEM

In Australia, increasing the representation of women in science, technology, engineering, and mathematics (STEM) is a national imperative. In 2016, the Australian Federal Government identified gender equality as a key platform in its National Innovation and Science Agenda.¹ Although the efforts of women to advance gender equality in STEM

remain central, men have been notably absent in these efforts despite holding the power and influence to create substantial change. Engaging decent and influential men to work beside women to accelerate gender equality in STEM is a major strategic opportunity and priority.

In 2016, the Australian Federal Government announced support for two complementary national programmes to tackle gender equality: the Science in Australia Gender Equity (SAGE) programme and the Male Champions of Change (MCC) STEM. SAGE is a partnership between the Australian Academy of Science and the Australian Academy of Technology and Engineering and is a programme aimed at improving the attraction, retention, and success of women, transgender, and gender diverse individuals in the Australian STEM higher education and research sectors. As of 2017, 45 higher education and research institutions are participating: 33 Australian universities (83% of all Australian universities), six medical research institutions, and six publicly funded research institutions. The programme requires participating institutions to analyse data on gender equity and develop action plans for improvement, and has largely been informed by the UK Athena SWAN.

The MCC STEM is a programme that brings together senior male leaders at the CEO level from business, government, university, and research sectors to “listen, learn, and lead through action”, with a view to taking practical action to accelerate progress on gender equality. In most organisations, those in high positions often receive information that is filtered and less critical feedback. The MCC programme flips this approach by asking leaders to listen to the insights of their employees and experts, particularly women, to reflect on the human experiences of gender inequality in their organisations and their own role, and to personally lead system-wide actions. MCC STEM provides one of the few spaces where senior men can step up beside their female counterparts to

For more on the Science in Australia Gender Equity see <http://www.sciencegenderequity.org.au/>

For more on the Male Champions of Change STEM see <http://malechampionsofchange.com/>

help drive change, and importantly, be held accountable for their actions.

The MCC STEM group brings together senior, influential male leaders who are committed to using their power and influence to deliver change in STEM. The MCC STEM strategy, in targeting only men, has been purposefully designed as a disruptive approach to challenge the status quo and accelerate gender equality. Since many STEM systems and structures were developed by men, and men typically hold the STEM senior leadership roles, engaging men is crucial for driving the transformational change that is required to the established systems, structures, and cultures that reinforce gender inequality. For example, MCC STEM has focused on redefining merit² to remove the gender bias inherent in many merit assumptions. By challenging male leaders to reflect on their application of merit, to call out biases, assumptions, and stereotypes, and ask “50/50 if not, why not?” at all stages of recruitment and promotion processes, a simple but disruptive strategy is put in place to affect change.

Although both programmes are designed to embed a systems approach to reversing gender inequality by moving beyond the common approach of “fixing the women” to instead focus on “fixing the system”, the two programmes use vastly different approaches. SAGE is a highly analytical, structured, and long-term programme that deploys a reflective process guided by the UK’s Athena SWAN,³ whereas the MCC STEM is a disruptive, experimental, and agile programme focused on CEO-led practical action within a short time-frame. There could be great value in these two programmes working together to accelerate the progress of gender equality in STEM, the collective achieving more than either programme alone.

In 2018, the two national programmes commenced a collaborative project to help accelerate change drawing upon the Leadership Shadow, which is a reflective analytical tool to

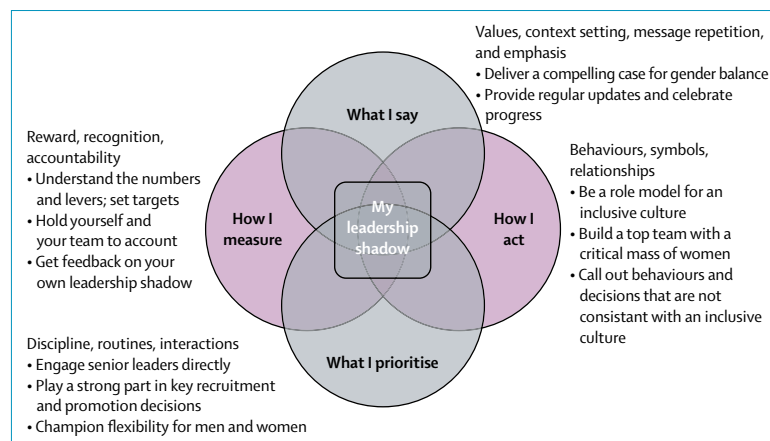


Figure: The Leadership Shadow, Male Champions of Change, and Chief Executive Women⁴

strengthen personal leadership on gender equality⁴ (figure). Noting the challenge many STEM institutions face in engaging senior male leaders in personally driving gender equality actions, in 2018, SAGE and MCC STEM convened a small group of male leaders from SAGE member institutions to reflect on their personal leadership and identify practical actions they can take to accelerate progress on gender equality. In doing so, this project supported leaders to accelerate progress by sharing learning between the programmes on effective gender equality leadership and identify practical actions to strengthen institutional performance on gender equality. An evaluation is currently underway and will be completed in 2019. Should this initial collaborative project show benefit, it will be expanded to include all SAGE senior leaders, both men and women.

Momentum is building internationally and there has never been a more important time for nations like Australia to show leadership in driving gender equality initiatives.^{5,6} We must share promising practical actions with others around the world. We must commit to ensuring that gender equality becomes an equal priority alongside research and innovation. Change starts at the top and engaging senior leaders is crucial to achieving this goal. We call on men in positions

of power to step up beside women and drive change in their sphere of influence.

JL and SC are affiliated with MCC. WE-A, JMR, and SSB are affiliated with SAGE. PVO declares no competing interests, but is supported by the National Institute for Health Research Biomedical Research Centre, Oxford, and by the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 709517.

Jane Latimer, *Somali Cerise, Pavel V Ovseiko, Jill M Rathborne, Saraid S Billiards, Wafa El-Adhami
somali@malechampionsofchange.com

School of Public Health, Sydney Medical School, University of Sydney, NSW, Australia (JL); Elizabeth Broderick & Co., Sydney, NSW, Australia (JL); Male Champions of Change STEM, Sydney, NSW 2001, Australia (SC); Radcliffe Department of Medicine, University of Oxford, John Radcliffe Hospital, Headington, Oxford, UK (PVO); Science in Australia Gender Equity, Canberra, ACT, Australia (JMR, WE-A); and National Health and Medical Research Council, Canberra, ACT, Australia (SSB)

- National Innovation and Science Agenda. Boosting innovation and science <https://www.innovation.gov.au/page/opportunities-women-stem> (accessed Feb 23, 2018).
- Chief Executive Women, Male Champions of Change. In the eye of the beholder. Avoiding the merit trap. 2017. <http://malechampionsofchange.com/wp-content/uploads/2016/08/MCC-CEW-Merit-Paper-FINAL.pdf> (accessed Feb 28, 2018).
- Ovseiko PV, Chapple A, Edmunds LD, Ziebland S. Advancing gender equality through the Athena SWAN Charter for Women in Science: an exploratory study of women’s and men’s perceptions. *Health Res Policy Syst* 2017; **15**: 12.
- Australian Human Rights Commission. It starts with us: the leadership shadow. 2014. <https://www.humanrights.gov.au/our-work/sex-discrimination/publications/it-starts-us-leadership-shadow> (accessed Feb 23, 2018).

- 5 Norton R. Women's health: a new global agenda. 2018. <https://www.georgeinstitute.org/videos/womens-health-a-new-global-agenda>. (accessed Feb 23, 2018).
- 6 Ovsieiko PV, Godbole RM, Latimer J. Gender equality: boost prospects for women scientists. *Nature* 2017; **542**: 31.

Supporting female scientists in Yemen

The contribution of Yemeni women to shaping the history and civilisation of ancient Arabia is well documented in the historical literature and the divine books of all the Abrahamic religions. The Sabaean Kingdom, which represents one of the oldest civilisations in South Arabia (modern day Yemen), was ruled by a powerful female monarch (Queen Sheba) who travelled to Jerusalem to meet with King Solomon and test his wisdom.

The Sabeian scriptures reveal societies in which women played major parts in trade, government, and all aspects of life. In the Islamic era, Arwa Al-Sulayhi was the first Muslim queen in the Arabian Peninsula and she built different schools, improved the economy, and supported agriculture in Yemen.

Despite the outstanding historical achievements of women in Yemen, the reality of today reflects a very sad image about their situation. According to the latest report on gender equality published by the World Economic Forum, Yemen is ranked last in the global gender gap index (149/149) and has only managed to close less than 68% of its gender gap.¹ Today, Yemeni women are still underrepresented in science, technology, engineering, and mathematics (STEM) and face particular challenges because of their societies' cultures and institutional rules. Yemen has not achieved gender parity in primary education and the gender gap substantially expands at higher levels of education. Early marriage and familial commitments are the main obstacles that present to women and girls in Yemen.² Stereotyping, prejudices,

and gender-based violence are also important issues that remain to be addressed.³

Many female scientists have reported experiencing some form of sexual harassment during their fieldwork and observations, ranging from inappropriate comments to undesirable physical contact. In addition, the absence of successful female role models in the field of science and engineering has also contributed to the low representation of female scientists in STEM.

The number of women graduating from universities with high degree classifications in STEM is increasing in big cities; however, it is clear that there are some barriers in the Yemeni and Arabic cultures preventing these women from pursuing research-oriented careers after graduation. The few career opportunities in research and scarcity of research-oriented graduate programmes are the most important obstacles.

In our opinion, Yemeni women are among the most resilient scientists in the world, and most of them are committed and dedicated to science and education despite the daily hardships without salaries and in conditions of dangerous conflict.

In 1996, the Prime Minister Abdul Aziz Abdul Ghani created the Women National Committee and different strategies were proposed to empower Yemeni women in different fields.⁴ In 2004, Arwa Alrabea was the first woman appointed as the Deputy Minister in the Ministry of Health in Yemen. 1 year later, Fawzeeh Noaman was also appointed as the first female Deputy Minister of Education. Consequently, many Yemeni women were hired in different academic and scientific positions and many of them became leaders of different academic and health institutions.

Despite all the difficult living conditions and the scarcity of resources and research support, several outstanding Yemeni female scientists have managed to establish active competitive research

programmes and achieve international recognition. Many of them built their own entities from the rubble and continued to battle against different obstacles. For example, the prize of the Organization for Women Scientists in Developing Countries (OWSD) was awarded for 4 consecutive years to Yemeni researchers in different fields: medical sciences, biology, chemistry, and mathematics. Several Yemeni female scientists are recipients of the Gro Bruntland award for women in sustainable development, The World Academy of Sciences (TWAS) prizes, and L'Oreal UNESCO fellowships.

For the great majority of female Yemeni scientists failure is not an option, and success is the only pathway to an independent and dignified life for themselves and their families. Dhekra Annuzaili is an exceptional Yemeni woman in the field of public health and has made an especially important contribution to the country's neglected tropical disease (NTD) control efforts in the 23 Governorates.⁵ Annuzaili is the WHO NTD Coordinator and also served as an advisor on health and development concerns for the UN, USAID, World Bank, and local non-governmental organisations in Yemen. As a result, she was named as the first to receive the 2017 Focus Exceptional Service award in Geneva, Switzerland. As a vulnerable setting, Yemen became progressively politically and economically unstable and female health-care professionals are striving to respond to new catastrophic situations and face different challenges to achieve the minimum goals of sustainable development.

Therefore, new initiatives led by women to promote the role of female scientists and health professionals in their communities should be launched by international communities to overcome this dilemma, and to empower young female scientists to pursue their research and to work alongside men to rebuild the country.

We declare no competing interests.