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SPECIAL FEATURE REVIEW

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Global perspectives to enhance strategies for advancing women in healthcare and STEMM leadership

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Abstract

The discourse surrounding gender equity has intensified recently, amplified by the impacts of the COVID-19 pandemic, highlighting the critical underrepresentation of women in leadership roles across various sectors including the media and healthcare. In medical research, this disparity is particularly pronounced, with women often excluded from senior positions despite their substantial presence in the workforce. This review seeks to explore the multifaceted issue of gender inequity in medical research leadership, examining the systemic barriers that women face, the socioeconomic factors that compound these challenges and the global variations in leadership representation of women. Diverse leadership teams are essential for fostering medical innovation, improving patient outcomes and ensuring that clinical trials and medical research are effective, inclusive and representative. The underrepresentation of women in leadership roles is not merely a matter of gender bias; it is intricately linked to socioeconomic factors that hinder their advancement. Women from lower socioeconomic backgrounds face additional obstacles, such as limited access to education and professional networks, which further exacerbate their underrepresentation in leadership positions. Moreover, cultural and societal norms play a significant role in shaping the career trajectories of women. As a group of immunologists, including representatives of the International Union of Immunological Sciences (IUIS) Gender Equity Committee, we review the causes of these inequities. We examine the impact of gender-diverse leadership on pre-clinical and medical research, emphasizing the need for inclusive leadership to drive progress in medical research and resulting healthcare. Finally, the review proposes strategies for improving gender equity in medical research leadership, including policy changes, organizational initiatives and societal shifts. By addressing these critical issues, this review contributes to the ongoing efforts to promote gender equity in medical research, ultimately enhancing the quality and inclusiveness of scientific inquiry and its impact on healthcare delivery.

INTRODUCTION

Women comprise approximately 50% of the global population yet, according to the United Nations (UN) Gender Inequality Index, which measures disparities in reproductive health, empowerment and economic status, women remain disadvantaged in political representation, access to health care, entry into education and

participation in the workforce.[1] These barriers significantly impact the development of women's capabilities and limit their potential contributions within a global society. Despite decades of extensive efforts across broad sectors, women continue to be underrepresented in leadership roles, limiting their influence and achievement of diversity and gender equity goals. A 2023 UN report estimates that it will take 140 years for women to achieve equal representation in leadership positions in the global workplace.[2] Women in Science Technology Engineering Medicine and Maths (STEMM) fields, however, should not have to wait that long to have their voices heard and their impact felt.

STEMM fields, including healthcare and medical research, are some of the most important employment sectors for women, where they make up 70–80% of the global workforce[3] and 59% of all medical, biomedical and health science degree graduates.[4] Globally, women perform the majority of unpaid care and domestic work in families and communities, and make the majority of health purchasing and use decisions.[5] Despite their central roles in healthcare delivery and decision-making, women continue to remain largely excluded from leadership positions. For example, if leadership roles were allocated proportionally, women who make up 70% of health workers, would also comprise 70% of health sector leaders. In reality, men, who represent less than 30% of the health workforce, hold 75% of leadership roles.[6] In high-income countries, the challenge is not how to attract women to STEMM fields (including medical research) but how to remove the barriers they face when advancing into leadership roles. The well-known "scissor" graph (Figure 1) illustrates this challenge, showing gender parity among students graduating in STEMM disciplines and entering the academic workforce, followed by a sharp decline in the number of women at middle leadership levels and an even greater underrepresentation in senior positions.[7] Australian data from 2014 to 2020 show some progress in increasing the representation of women in middle and senior leadership roles, yet significant improvement is still needed.[7] Identifying the barriers to career advancement, including individual, institutional and systemic, is critical to initiate mechanisms of change to achieve gender parity. By educating individuals to challenge biases, through the promotion of inclusive policies within organizations, and enhancing professional development opportunities, systemic barriers can be dismantled (Box 1). Organizations, professional societies and funding bodies can support women by implementing equitable practices, such as mentorship programs, diversity reporting, inclusive hiring, and prioritizing funding for women-led initiatives. Across society, normalizing women's leadership, involving men as allies and shifting cultural norms will create environments where women can thrive, lead and contribute to healthcare and STEMM advancements.

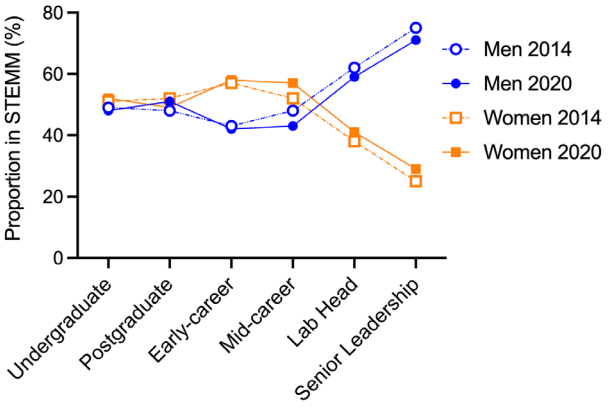

Figure 1. Scissor graph of gender representation across academic levels in STEMM in Australia. This graph illustrates the trend in gender representation in STEMM fields with Australian data from 2014 (---, open symbol) and 2020 (—, filled symbol).[7] At the undergraduate level, student enrolments in STEMM are gender-balanced. However, as academic levels increase from mid-career researchers to senior leadership there is a marked divergence, with an increasing proportion of men (blue) and a corresponding reduction in the representation of women (orange). This "scissor" pattern highlights the persistent gender disparity at higher academic ranks, where women's representation declines significantly.

The vital role of women in healthcare professions

Health leadership and policy decision-making significantly affect women. There is a disparity between the policies that impact women and the level of input they have in the decision-making process. Women are not only directly affected by policies centered around reproductive, maternal, newborn and child health, but also by health policies in less obvious ways. For example, in areas such as immunization, women are often responsible for taking children to be vaccinated and can face barriers to obtaining vaccinations. Adolescent girls are one of the groups with the highest rates of HIV infection, due in part to gender inequalities, which can result in girls being disempowered to negotiate safe sex; poverty that manifests as communities located far from healthcare centers; and a lack of access to HIV prevention and sexual and reproductive health programs.[8] The prioritization of issues and the allocation of resources are influenced by who makes the decisions – more diversity, including women, allows leaders and policymakers to more effectively draw attention to and address neglected issues.

Box 1. *Successful strategies and initiatives to promote gender equity in healthcare and STEMM*

What an individual can do:

- **Educate yourself on allyship** by advocating for inclusive environments or cultures to benefit everyone whilst avoiding approaches that focus on helping or fixing individual women.
- **Disrupt biases** in social, educational and professional settings by calling out and correcting societal assumptions.
- **Increase exposure to positive and diverse role models in STEMM from an early age**, whilst actively removing negative stereotypes through books, media, school and personal settings.
- **Bridge the encouragement gap** between parents, educators, caregivers, supervisors and mentors to retain girls and women in STEMM by fostering a growth mindset.
- **Promote STEMM education for girls and women** through programs, initiatives, scholarships and mentorships from a young age (see Case Study 1 – Connecting girls to STEMM professionals through a pen pal program).

What an organization can do:

Lead across levels

- **Require a clear and transparent commitment by leadership** including the head of the organization, or governing body, to changing the environment towards equity, understanding this is a long term investment.
- **Amplify women's voices and ideas (workplace advocates)** to ensure everyone is heard, and nobody feels ignored or quieted down. Through amplification, organizations can help to give credit and recognition to the right person. This can be achieved through actively recognizing and giving credit to women's contributions in meetings, presentations and publications.

Improve accountability

- **End the "default is man" bias and prioritize accountability for policies that support women** including:
  - Establish legal frameworks to ensure zero discrimination and harassment.
  - Perform regular audits to identify and rectify wage gaps to achieve pay equity. Transparent salary ranges and start-up funds for each role can also dissuade inequality in pay and negotiation processes.
  - Normalize flexible work arrangements by offering flexible working hours, remote work options, reasonable parental leave policies and part-time alternatives.
  - Create family-friendly policies such as safe and appropriate spaces for nursing mothers.

Create opportunities

- **Support return to work programs or internships**, which provide training and the opportunity to refresh skills for parents and carers. Part-time work and other supports can also be introduced to make the transition back into STEMM smoother.
- **Foster an inclusive workplace culture that challenges workplace biases and stereotypes** including:
  - Provide regular diversity and inclusion training, establish employee resource groups for women and ensure that company policies protect against discrimination and harassment.
  - Address unconscious biases and discrimination, such as gender or age bias.
  - Identify confirmation bias and attribution bias, which can be mitigated by standardizing questions during the interview process and fostering open communication.
- **De-bias practices and policies in performance evaluations and promotions**, including accurately and transparently applying career disruptions and relative to opportunity in the evaluation metrics.
- **Implement diverse hiring practices** by creating inclusive job descriptions, widening recruitment channels to reach diverse groups, implementing blind recruitment processes to minimize unconscious biases, and establishing diversity hiring goals.
- **Champion female role models** by highlighting and celebrating the achievements of women in STEMM to inspire others and make the path seem more attainable. Featuring female role models in leadership positions, guest lectures and media opportunities can help to change perceptions and encourage more women to aim for higher roles. Recognize that these roles also cost time and resources for the women involved and compensate or reward these additional efforts.
- **Commit to hiring or appointing women for leadership roles**, especially those that have never been held by women, providing fast-track measures to correct the gender imbalance in global health leadership. Quotas and all-women shortlists can be created which can be interim measures to redress the gender imbalance and removed when no longer required (see Case Study **2** – Women-only academic recruitment).

Promote professional development for women

- **Offer continuous learning and development opportunities** including:
  - Establish mentorship and sponsorship programs. Good mentoring programs lead to better career success for people and help companies with employee happiness, retaining staff and sharing knowledge.
  - Provide access to training programs, summits or conferences specifically designed to increase discussions on supporting women in STEMM.

Box 1. Continued.

- Create tailored leadership opportunities for women from marginalized backgrounds who may have missed out on formal education and other opportunities.
- Provide support for women to work collectively through trade unions, professional associations and global movements (see Case Study 3 – Establishing a grassroots-driven non-for-profit diversity and inclusion advocacy organization).

What a professional society can do:

- **Establish diversity and inclusion committees** to drive initiatives, opportunities and policies at a grassroots level with discipline specific goals.
- **Create women mentoring programs** to increase connections with senior women leaders and improve peer-peer networks.
- **Require diversity and inclusion reporting at conferences** to support gender equity in symposium organizing committees, chairing and speaker invitations as well as the availability of childcare.
- **Provide carer travel grants** to support professional development, networking and visibility, including conference attendance and laboratory visits.

What clinical trials teams can do (reviewed[42]):

- **Ensure diversity of the trial governance and steering committees**, as local researchers and federal and industry sponsors of clinical trials.
- **Ensure geographic, institutional and trial site diversity of lead clinical investigators**.
- **Encourage women to serve as site principal investigators**. For example, by a departmental head allowing sufficient time to permit the additional responsibility.
- **Recognize that women are competent to lead all clinical trials**, not only those relevant to a female patient population.

What funding bodies can do (reviewed[74]):

- **Create structures to allow priority funding for women scientists**. For example, the Australian Government's lead agency for funding health and medical research implemented a model to improve the number of grants awarded to women under the Australian Sex Discrimination Act 1984. This action maintains a generation of mentors for future leaders.
- **Use quotas to award equal numbers and equal funding amounts** for women- and men-led grants (see Case study 4. Equal grant funding for women and men).
- **Improve guidelines to document and evaluate career disruptions relative to opportunity** sections in grants, including the long-term impacts of COVID-19.
- **Provide meaningful unconscious bias training in peer review panels**. This could include a requirement to prove understanding and reflection, rather than just providing an optional list of materials.
- **Introduce caps on funding limits** for individual investigators to ensure fairer distribution of funds.

What all members of society can do:

- **Show women in health and STEMM as leaders in their own fields and drivers of change**, rather than primarily service users. The concept of leadership within society needs to be re-examined to recognize that women community workers, for example, may be health leaders in their area and deserve recognition.
- **Highlight women healthcare and STEMM leaders in the media as experts and innovators**, showcasing their discoveries, achievements and contributions, for example inviting women discipline-experts to be interviewed for news articles.
- **Normalize work-life balance for everyone**.
- **Mobilize men as allies to create more equal workplaces**. For example, normalize paternity leave and other family-friendly policies that shift gender norms and more equally distribute the burden of unpaid work at home. Gender equality efforts are most effective when they involve everyone, and have even been shown to be responsible for improving women's return to work, including boosting women's earnings.[75,76]

Research shows that being female increases the risk of developing some of the most challenging health conditions. Autoimmune diseases, for instance, affect approximately 8% of the global population, and 78% of those affected are women.[9] Women are three times more likely than men to develop rheumatoid arthritis[10] and four times more likely to be diagnosed with multiple sclerosis.[11] Two-thirds of people with Alzheimer's disease are women,[12] and women are three times more likely than men to suffer a heart attack.[13] Women are also at least twice as likely as men to experience chronic pain conditions such as fibromyalgia, chronic fatigue syndrome and migraine.[14] In 1977, the US Food and Drug Administration (FDA) recommended excluding women of childbearing age from clinical research studies, a policy aimed at protecting unborn children following

the thalidomide tragedy.[15] Another reason commonly cited for the exclusion of women from clinical trials was the hormonal variation across the menstrual cycle, which was seen as a confounding factor that would increase the cost of trials by requiring more participants. However, this exclusion has led to the administration of drugs unsuitable for women, significantly heightening the risk of adverse events. Indeed, between 1997 and 2000, eight out of ten drugs removed from the US market were withdrawn due to side effects that predominantly affected women.[16] Between 2004 and 2013, US women experienced over 2 million drug-related adverse events, compared with 1.3 million for men.[17] In the UK, less than 2.5% of publicly funded research is dedicated to reproductive health, despite one in three women experiencing a reproductive or gynecological health issue.[18] In 1998, the FDA issued a rule requiring drug manufacturers to provide evidence of a drug's safety across different ages, sexes and races, and researchers are now required to consider sex as a biological variable in both animal and human studies.[19] By 2016, significant progress had been made, with women accounting for roughly half of participants in clinical trials funded by the US National Institutes of Health (NIH),[20] yet representation of women leading trials is still largely underrepresented.[21,22]

The absence of women in leadership positions has significant implications for patient care and clinical research. Women bring diverse perspectives and experiences to leadership roles, which can result in more comprehensive and patient-centered care, particularly when addressing health issues that predominantly affect women.[23] In addition, women leaders are more likely to advocate for the inclusion of diverse participants in clinical trials,[24,25] a critical factor in understanding how medical treatments affect women differently and in developing gender-specific therapies. Research has also shown that gender-diverse leadership teams are associated with improved patient outcomes,[26] as women leaders, who may be better attuned to the specific healthcare needs of women and other underrepresented groups, bring diversity of thought, which can result in innovative solutions to complex problems. This diversity enhances the ability to meet the diverse needs of patients and stakeholders, leading to more patient-centered care and better health outcomes overall. Organizational support and encouragement of women to serve as principal investigators, along with the recognition that women are capable of leading all clinical trials, not only those relevant to a female patient population, will improve diversity of lead clinical investigators (Box 1).

The underrepresentation of women in global healthcare leadership

Women are underrepresented in leadership positions at Fortune 500 healthcare companies, global health organizations, top medical schools and departments of health in every country.[5] Healthcare is one of the most important employment sectors for women. In many countries, the majority of nurses, midwives, pharmacists, dentists and physicians under 40 are women. While women make up 70% of the global health workforce, they only hold 25% of leadership roles. In 2022, women led only 23% of World Health Assembly delegations, and just 30% of deans at leading public health and medical schools globally were women.[5] In Kenya, for instance, women hold 42% of mid-level positions and 40% of top leadership roles across the private, public and NGO sectors in health.[5] In Nigeria, women occupy only one-third of leadership roles in health organizations, and just one of the 28 directors of federal medical centers is a woman.[5] In India, women hold approximately 28% of leadership roles in national health organizations, though representation varies greatly, with some organizations having almost no women in leadership positions.[5] The COVID-19 pandemic further exacerbated this disparity, with 85% of national pandemic task forces dominated by men.[5] Women of color and from marginalized backgrounds face the greatest exclusion from leadership positions in healthcare. Indeed, only one major global health organization, the Joint United Nations Programme on HIV/AIDS (UNAIDS), is headed by a woman from a low-income country.

Women are frequently employed in roles that are accorded lower social value, status and pay, such as public health nursing and unpaid community health work. This gender segregation allows men to dominate leadership roles as doctors and policymakers. For women in community health, there is often no career path from unpaid work to formal, paid health jobs. This deep gender segregation is rooted in the historical exclusion of women from studying and practicing medicine, compounded by ongoing gender discrimination and bias within the field. It is widely recognized that females are underrepresented in almost every country across the spectrum of surgical subspecialties.[24,27,28] A recent systematic review demonstrated that lack of progression in career development of female surgeons perpetuates the imbalance.[29] Gender equity statements and policies among professional surgical societies were recently catalogued as deficient.[30] Additionally, gender norms often assign women the bulk of unpaid care work at home, while the "motherhood penalty" poses significant barriers for pregnant women and new mothers. Systemic

gender bias also limits women's opportunities through restricted access to education, cultural norms and inadequate legal protections against sexual harassment in the workplace, alongside persistent gender disparities in hiring and pay. Mobilizing men as allies to create more inclusive and equal workplaces, whilst avoiding approaches that focus on helping or fixing individual women, will significantly advance gender norms (Box 1). Organizations can implement policies that promote accountability and equity, such as legal frameworks against discrimination, regular audits to address wage gaps, transparent salary practices, support of flexible work arrangements and creating family-friendly policies. By normalizing paternity leave and other family-friendly policies the burden of unpaid work at home will be more equally distributed. Gender equality efforts are most effective when they involve everyone, and have even been shown to be responsible for improving women's return to work, including boosting women's earnings (Box 1).

Persistence of gender inequities in clinical trial leadership

The importance of women leading clinical trials cannot be overstated. The lack of women leadership has implicit impacts on the diversity of participants in trials, as women-led trials are significantly more likely to enroll female participants,[24,25] crucial for understanding sex-specific health outcomes. Yet, of the clinical trial results published in the *Journal of the American Medical Association* (JAMA), *The Lancet* and *New England Journal of Medicine* from 2014 to 2018, women constituted only 10.1% of clinical trial leadership committees.[31] Indeed, a global study of 245 771 clinical trials demonstrated women comprised 32.4% of principal investigators (PIs) compared with men at 63.5%.[25] Researchers observed the lowest proportions of female principal investigators for clinical trials involving cardiology (20.3%) and hepatology (21.4%), followed by ophthalmology, pulmonology, gastroenterology, urology, hematology and oncology.[25] In oncology clinical trials conducted between 1999 and 2019, only 11 516 (27.7%) of the 39 240 PIs leading clinical trials were women.[25] An analysis of clinical trials run by the Australasian Gastro-Intestinal Trials Group found of all PIs, 20.2% were women and women were more likely to be a co-PI (42%) as opposed to sole PI (18%).[24] Similarly, of the 335 Australian clinical guidelines published during 2010–2020, the proportion of women in guideline development groups was less than 40%, and 280 of 511 chairs (55%) were men.[32] Addressing this underrepresentation of women as PIs and in therapeutic guideline development is critical to promote equity in design and importantly will produce better data about the effect of proposed clinical therapies on half of our population.[33]

One startling observation since 2004, is a consistent annual increase of only 0.65% in women PIs.[25] Conversely, the highest proportions of female PIs lead obstetrics-gynecology clinical trials (43.9%).[25] Analysis by geographic distribution revealed higher female representation among clinical trial PIs in North America and Europe compared with Asia.[25] Further evidence of systemic bias in clinical trial leadership emerged during the COVID-19 pandemic. In 2020, only 28% of US COVID-19 clinical trials were led by women PIs, while the proportion of women as first authors in biomedical research publications declined by 9.1%.[34–36] The impact was even more pronounced in COVID-19-related research, where the percentage of women first authors dropped by 28%.[34–36] The underrepresentation of women experts during coverage of the pandemic highlights the pivotal role the global media could play in increasing the visibility of women leaders in healthcare and STEMM (Box 1). By amplifying the voices and achievements of women, the media can inspire greater recognition, promote diversity in scientific discourse and support women in improving academic metrics.

Why are women not equally represented in healthcare leadership?

Barriers to entering STEMM academia

In Australia, gender equality in academia has been closely monitored since the mid-1980s. In response to government legislation, regulatory frameworks and university gender equity strategies, Australian universities have implemented significant changes to address gender disparities. By 2014, women represented 44% of academic staff in Australian universities and held 31% of senior positions.[37,38] Yet, a decade later, women remain underrepresented in senior academic roles. The issue is not unique to Australia, with women disproportionately found in lower ranked academic positions compared with their male colleagues, particularly in senior faculty positions, with men outnumbering women academics by 41% at the Professor level.[37] In the European Union, the percentage of female academic staff in full Professor positions varies by country, ranging from 13% to 54.3%, with women overrepresented in humanities, social and medical sciences but underrepresented in engineering, technology and natural sciences.[39] Similar trends are seen in the UK, where women are more likely than men to occupy lower-ranked academic positions.[37] Despite women making up the majority of medical school students in most high-income countries, they remain

underrepresented in senior academic leadership positions, including editorial boards of biomedical journals that publish clinical research and landmark findings in medicine,[40,41] and in clinical trial leadership.[42]

In socio-economically marginalized countries, there are limited data on the participation of girls in STEMM education. A United Nations Educational, Scientific and Cultural Organization (UNESCO) analysis that examined childhood education in 120 countries found no systemic national assessment data of student performance for science.[43] While the report highlights significant progress in educational attendance and enrolment over the past 20 years – with a gender gap of less than one percentage point in primary and secondary education – the participation of girls still lags behind in certain regions, particularly in Sub-Saharan Africa and South Asia.[43] In rural areas of Sub-Saharan Africa, where poverty is widespread, many girls continue to face formidable barriers to accessing education. However, the available data do not fully capture the gender barriers rooted in societal norms and stereotypes. Although beyond the scope of this review, increased data collection, analysis and transparency is required in low- and middle-income countries (LMICs) to ensure the drivers of change do not become exclusive. Tackling these gendered barriers requires targeted efforts, including disrupting societal biases in educational and professional settings, advocating for policy changes, and creating programs that specifically address gender disparities. By promoting and improving equitable access to STEMM education through scholarships, mentorships and inclusive initiatives, girls in marginalized regions can be empowered to overcome systemic obstacles and to realize their potential in STEMM fields (Box 1). Increasing exposure to positive and diverse role models in STEMM from an early age (Case study 1), whilst actively removing negative

Case study 1. Connecting girls to STEMM professionals through a pen pal program

Approach: STEMpals is a pen pal program run by *Curiosity Factory*, a charity, that was founded by Dr Jennifer Payne, with the support of *The Generator*, Monash University's entrepreneurship hub for start-ups. The program connects Australian grade 5 and 6 students (ages 10–13) with STEMM professionals, so students can be who they can see. Every student is paired with their own STEMM professional based on shared hobbies and interests. STEMpals exchange one letter per term relevant to a theme which guides the exchange and classroom planning.

Experience: Although handwritten letters are delivered digitally, teachers print them to create a tangible and engaging experience for the students. Each term, the letters are presented at a Letter Party, where students celebrate their newfound knowledge and connections. STEMM professionals also benefit, as it encourages curiosity and development of their own STEMM communication, as well as fresh perspectives on their career thanks to the student's questions. The program demands little time commitment with STEMM volunteers dedicating about 1 hour per letter, at a time that suits them throughout the year.

Impact: In 2024 alone, 3300 letters were exchanged and 745 students were inspired around Australia. At this age, students are making decisions about their futures based on biases. STEMpals exposes the classroom of students to a diverse range of STEMM mentors carrying out diverse jobs, breaking these biases. The program documents this change as the students draw a STEMM professional at work at the start, then again at the end of the program. Students go from drawing old white men in lab coats to teams of people working together in diverse situations, and even drawing themselves.

Teachers report increased engagement and enthusiasm for STEMM among their students, with one commenting, "The students are always excited to receive their letters. It's amazing to see how their questions evolve and become more sophisticated with each exchange". A low-tech pen pal program ensures all students can be included and inspired with real world STEMM, especially those in remote, regional and low socioeconomic areas.

Additionally, this program supports Australian primary school teachers, many of whom lack confidence in teaching STEMM due to limited training. Teachers report increased confidence in teaching STEMM areas they would never have considered before, due to STEM professionals explaining their STEMM in engaging and easy to understand ways through STEMpal letters. The impact is not only increased engagement with STEMM but leads to students engaging in writing as they want to write a reply and ask questions to their very own STEMM professional. One teacher commented, "this is the most enthusiasm I have ever seen for writing from my kids".

Challenges: As a program run by a not-for-profit, it is reliant on volunteer STEMM professionals and the continued engagement of teachers and schools. The need for volunteer staff and limited funding can create issues with long-term stability of the program which is being tackled via diversification of funding opportunities.

Further reading:

[77]https://stempals.org.au/.

[78]https://www.monash.edu/monash-innovation/news/what-does-a-scientist-look-like-monash-university-generator-start-up-champions-curiosity-in-primary-school-students.

stereotypes through books, media, school and personal settings and actively bridging the encouragement gap between parents, educators, caregivers, supervisors and mentors will enhance the retention of girls and women in STEMM by fostering a growth mindset (Box 1).

Challenges to retaining women in STEMM

In 2023, the gender gap in labor-force participation, measured at 0.64 (on a scale from 0 to 1, where 1 indicates parity), reached its second-lowest point since it was first reported by the World Economic Forum in 2006.[44] Gender inequality in the workforce stems from a confluence of barriers (Figure 2), including reduced participation due to career disruption and expected societal caregiving responsibilities, societal and systemic bias regarding women's credibility in leadership roles including perceived assumptions about their capability and confidence,[4] and exclusion from professional networks that provide sponsorship, collaboration and visibility. In medicine, while early-career male and female doctors progress similarly, women are five times more likely to experience family-related career disruptions, significantly affecting their long-term career advancement[45] (Figure 3). Women often face disadvantages in merit-based promotion systems that frequently fail to account for their unique challenges and opportunities. As a result, women are twice as likely to leave their careers compared with men,[46,47] more likely to change academic positions[48] and less likely to be awarded tenure.[49] For women in nursing, midwifery and allied or social roles, the problem is compounded by the undervaluation of these professions as "women's work".[50] Gender inequity in healthcare and medical research leadership results in a loss of critical skill and experience, low morale, increased costs of sustaining the workforce and adverse impacts on healthcare, clinical research and policies affecting women and children.[48,51,52] Importantly, research continues to focus on the gaps and the barriers to women's career progression, rather than on potentially

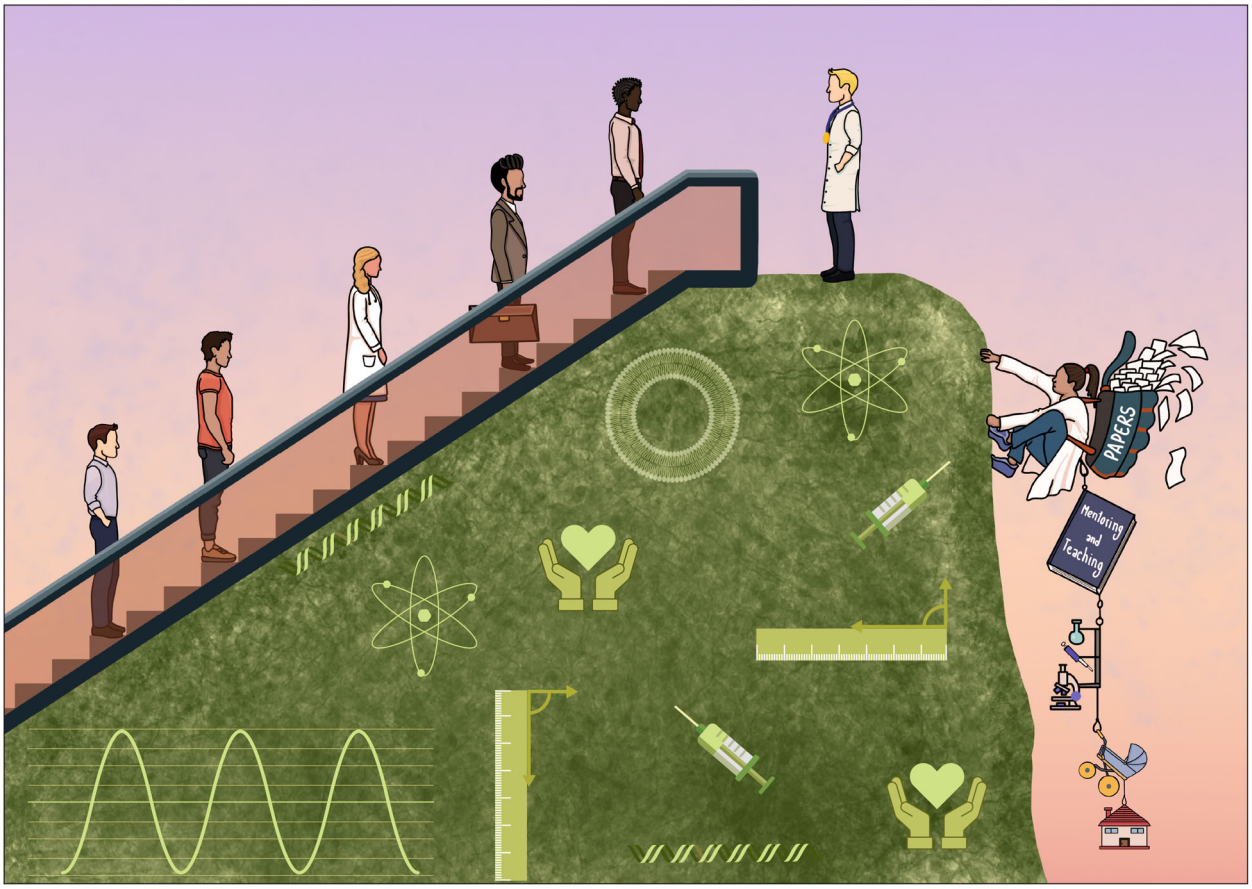

Figure 2. Key gendered barriers to equal access to healthcare and STEMM leadership. Key gendered barriers to access to healthcare and STEMM leadership positions include biased evaluation practices, an implied obligation of service, a higher load of laboratory and service work, a greater expectation for pastoral care, heavier teaching commitments and a disproportionate share of family care and household responsibilities.

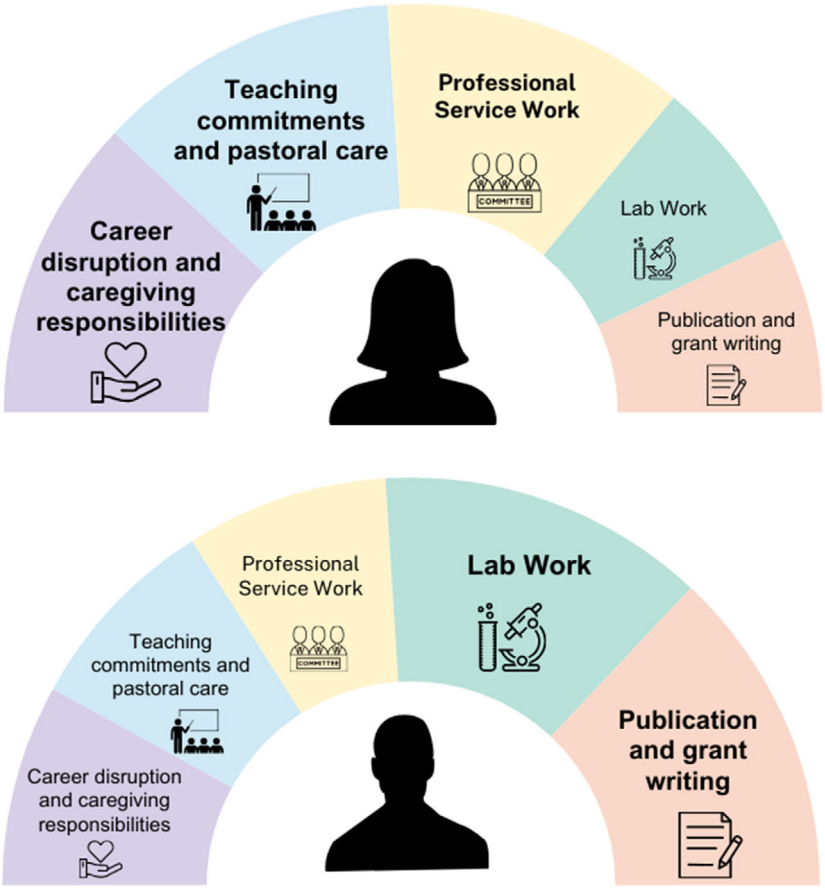

Figure 3. Depiction of gender disparities in time allocation to tasks contributing to inequities in medical research careers. The depiction illustrates that women are more likely to experience career disruptions and have caregiving responsibilities, along with higher commitments to teaching, pastoral care and professional service work. Conversely, men allocate more time to laboratory work, publication and grant writing, activities that are more highly valued in academic promotion systems. This disparity shows that women's increased responsibilities outside of laboratory work and research output hinders their career progression and contributes to systemic inequities in academic advancement.

effective strategies to advance women in leadership[4] (Box 1).

The UN has identified that women only comprise 30% of the global pool of academic researchers[53] and often face gender-based discrimination and an absence of equal opportunities to develop their research capabilities and scientific discoveries (Figure 3). In academia, women often face a disproportionate burden of responsibilities while receiving less pay than their male colleagues.[53] These burdens include the implied obligation to serve on committees and in other service roles, explicit provision of pastoral care and greater teaching commitments than men (Figure 3). Collectively, these demands reduce the time available for research, authoring journal articles and preparing grant applications, all of which are critical for career advancement, and leadership opportunities (Figure 3). These disparities were exacerbated during the COVID-19 pandemic, leaving many women academics without clear mechanisms to account for the impact on their career progression relative to opportunity.[54,55] Since academic promotion typically places more emphasis on research productivity than teaching activities, this imbalance negatively impacts women's career progression[56] (Figure 3). Additionally, traditional metrics of research excellence (such as the number of publications and the impact of publications, success in grant applications and student evaluations) that are required for promotion or appointment to senior roles, are prone to gender bias.[57] Women academics in STEMM have lower publication rates,[58] more career interruptions and shorter publishing careers compared with men,[59] resulting in a gap between the promotion rate of men and women[38] making these factors significant challenges in retaining women in STEMM. By de-biasing

Case study 2. *Women-only academic recruitment to improve gender equity in the STEM workforce*

Approach: To reach a target of 40% women researchers by 2026, the ARC Centre of Excellence for Transformative Meta-Optimal Systems in Australia, implemented a women-only recruitment round.

Experience: The Centre shared their learnings on LinkedIn highlighting their key lessons including the importance of having defined resources (including financial) to support diversity and inclusion initiatives. They were able to successfully appoint five women researchers from this round, but honestly discussed challenges related to international recruitment and COVID-19, among others, meaning they have still struggled to reach their gender target.

Impact: Whilst the recruitment round may not have delivered the gender target the Centre was aiming for, they noted other benefits including implementing other diversity and inclusion activities with a focus on building awareness within the leadership team. Similar additional impacts have also been reported in other women-only recruitment initiatives.

Challenges: The Centre involves five different universities across four different states and territories, with different legal requirements – notably they were not able to offer women-only positions in Western Australia. They also found that many men applied anyway, despite the "women-only" advertising. Building upon a point above, as the recruitment was during 2020 and Australia was one of the most locked-down countries globally, they struggled with international recruitment and had to offer appointments to pre-existing students and researchers within their network to fulfill their scientific objectives.

Further reading:

[79]https://www.tmos.org.au/idea/five-lessons-from-our-women-only-recruitment-round/.

[80]https://www.nature.com/articles/d41586-024-00212-7.

practices and policies in performance evaluations and promotions, fostering an inclusive workplace culture that challenges workplace biases and stereotypes, and promoting work–life balance for everyone, significant impacts can be made to improve the retention of women (Box 1). Grass-roots initiatives and programs of diversity and equity advocacy can further empower those that contribute and result in organizational participation, education and change (Case study 2).

Inequitable evaluation of leadership quality

A key component of academic merit evaluation including grants, peer review, journal publications and promotion panels, continues to spark debate in regard to transparency and fairness. Women are underrepresented as authors,[60] with their publications less cited than men,[61] which further compounds the quality of their applications for fellowships or investigator-initiated grants. Cumulatively, this impacts the grant success of women researchers, with men's applications scored more competitively and positively than applications led by female investigators.[62,63] An international meta-analysis of 21 studies revealed that male applicants had a 7% greater success rate than female applicants in grant or fellowship funding.[64] Overall, this disparity results in male investigators viewed more easily as scientific leaders than women.

New Zealand has used a research performance dataset to score every individual academic's holistic research performance to understand the unconscious bias underlying perceptions and judgment of a researcher's CV. An analysis of this dataset revealed that men were more than twice as likely to be ranked at professorial level than women, despite similar scores.[65] Similarly in the Netherlands, men had higher grant success rates because they received higher "quality of researcher evaluations", but not "quality of proposal" evaluations, resulting in 4% fewer women awarded funding.[66] In 2014, the Canadian Institutes of Health Research adjusted its funding structure to evaluate the impact of the researchers separately from their research proposals. In the new program with an explicit review focus on the caliber of the PI, the gender gap had increased from 0.9% more success for men than women in the original structure, to 4%, demonstrating that gender gaps in grant funding are more attributable to differences in evaluations of the caliber of male and female researchers.[67] This finding aligns with outcomes in the US, where women applicants to the National Institutes of Health's R01 grants program are less likely than male applicants to be described as leaders.[63]

In Australia, research projects can be led by a sole investigator (as the only named PI) or as a team of investigators, with multiple PIs, including a lead individual. A recent 20-year analysis in Australia found that women were awarded fewer sole investigator grants, and more team leadership grants as lead PI, than men.[68] Across all career levels, the percentage of all sole leadership grants awarded to women was below gender parity (50%).[68] Between 2000 to 2020 of the $13.2 billion awarded to team

investigators, $9.5 billion went to men-led projects and only $3.7 billion went to women-led projects. Similarly, of the $2.8 billion awarded to sole investigators, $0.7 billion went to women and $2.1 billion went to men.[68] Collectively, these data reflect that men are preferred as both sole investigators and leaders of research teams. Interestingly, teams led by women had greater diversity, with a higher percentage of women in the team (32%) compared with male-led teams (24%).[68] Funding bodies can advance gender equity by prioritizing funding for women scientists, as demonstrated by the Australian Government's model under the Sex Discrimination Act 1984 (Box 1). Australia's peak funding body, the NHMRC, implemented quotas to ensure that equal grant distribution and funding amounts were awarded between women- and men-led projects (Case study 4). Although only applied since 2022, it will be interesting to analyze the impacts this has on supporting the research and career trajectories of women researchers, and whether this has a significant impact on the upward curve of "scissor graph" in Australian academia.

Compounding discrimination due to social inequity and societal effects

In some low-income countries, low levels of education and literacy restrict the level at which some women can enter the health workforce, and prevents them from progressing to leadership. Despite their critical roles in delivering primary health care and as community leaders, women community health workers are typically excluded from formal leadership opportunities. Patriarchal cultures where leadership is often viewed as a male role, as seen in India, Kenya and Nigeria, limit women's participation in the workforce.[69] For instance, in India, only 24% of women are in the labor force compared with 79% of men, and while women average 28% of leadership roles in health organizations, some sectors, such as the Pharmacy Council, have almost no female representation.[70] In sub-Saharan Africa, female labor force participation rates are stagnating despite the rise in women's educational attainment.[6] In Kenya, despite patriarchal challenges, women hold 42% of mid-level and 40% of top-level health leadership roles.[6] Nigeria, however, presents a "glass ceiling", with women occupying about one-third of leadership roles in health organizations, but only a few holding senior government positions (5 out of 30 national ministers/commissioners, and only 1 out of 28 Directors of Federal Medical Centers are women).[6] Women in Nigeria also face a "motherhood penalty", with mothers, and potential mothers, suffering a penalty in the form of lower perceived competence and commitment, higher professional expectations, a lower likelihood of being hired, rehired, promoted and lower recommended salaries.

Gendered stereotypes and biases further affect women's leadership progression across these countries. For example, women displaying assertive traits are often labeled as "bossy" or "aggressive", and research from Pakistan highlights similar discriminatory barriers, including nepotism and the existence of a "boys' club", with 65% of women reporting gender-specific obstacles in their career advancement.[6] Interviews with 85 women health leaders in Pakistan revealed similar discriminatory experiences.[5] Over a third of respondents said that they did not receive equal career advancement opportunities as men with the same experience and qualifications.[5] Forty percent made note of "boys' club" as the most significant barrier to leadership, alongside nepotism and lack of women-friendly workplace policies, and gender specific barriers to career progression were experienced by 65% of the women.[5]

How to retain, promote and increase the visibility of women leaders in healthcare

Systemic barriers, entrenched biases and societal expectations continue to limit women's advancement to leadership positions and equitable opportunities. Addressing these issues requires a multi-faceted approach that includes policy reforms, organizational efforts and societal changes. By implementing targeted strategies at each of these levels, healthcare and STEMM sectors can create more inclusive environments that empower women, enhance leadership diversity and contribute to the overall success of these fields (Box 1).

Importantly, the focus should move beyond existing strategies that primarily focus on "fixing" the individual, rather than addressing the organizational and systemic challenges that contribute to gender disparities. Traditional approaches have focused on encouraging women to be more assertive and to "lean in" by providing initiatives to improve what is perceived as essential "traits" to achieve leadership positions, such as confidence, assertiveness, risk-taking, negotiation and leadership skills. Yet, these initiatives have largely failed to address systemic inequities because they are often based on, and reinforce, stereotypes about what women supposedly "lack". This focus on changing women themselves places the responsibility for addressing inequality on women, perpetuating the idea that they are to blame for their own underrepresentation in leadership roles. To promote gender equity in STEMM and healthcare at an individual level (Box 1), it is crucial to advocate for inclusive environments, challenge

biases in social and professional settings, and provide diverse and positive role models from an early age. Encouraging a growth mindset and bridging the support gap among parents, educators and mentors can help to retain girls and women in STEMM. Additionally, fostering STEMM education through targeted programs from a young age that provide mentorship opportunities, such as connecting girls to STEM professionals in pen pal programs (Case study 1), act to empower the next generation of women leaders.

The European Commission highlights that systemic inequities in the workforce are perpetuated by gender-based barriers stemming from organizational constraints and cultures, which are often unrelated to individual capability. These restrictive norms fail to fully harness the potential of the workforce by expecting women to operate within systems designed by, and for, traditional male roles and life patterns,[49] significantly impacting social, economic and health outcomes.[71] Indeed, research indicates that addressing structural issues and workplace norms at an organizational level is essential.[49] To advance gender equity in the workplace, healthcare and STEMM organizations should lead through transparent, long-term commitments, amplify women's voices through advocacy, and improve accountability by addressing biases and implementing equitable policies (Box 1). This includes ending pay gaps, normalizing flexible work arrangements, and ensuring family-friendly policies to foster an inclusive workplace culture and end the "default is man" bias. Creating inclusive opportunities involves supporting return-to-work programs, implementing diverse hiring practices and de-biasing performance evaluations and promotions, and actively championing female role models through the commitment of hiring and appointing women into leadership roles. Indeed, women-only academic recruitment has been introduced across many fields in STEMM and healthcare, resulting in an increase in women leadership (Case study 2). Organizations can also enhance professional development

Case study 3. *Establishing a grassroots-driven not-for-profit diversity and inclusion advocacy organization*

Approach: In 2014 Women in Science Parkville Precinct (WiSPP), was established in Victoria, Australia, creating a centre which united the workforce from Australia's five largest medical research institutes to advocate for systems changes for women in STEMM. WiSPP has worked with over 100 volunteers who have contributed to the development and delivery of programs to support the entire STEMM ecosystem; from individuals to entire organizations.

Experience: Through funding from the five institutional partners and government grants WiSPP has established a number of initiatives to retain, support and promote women in STEMM including: (1) supporting leading researchers by the provision of an executive mentoring program; (2) supporting early and mid-career researchers in Cross Institute Grant Preparation Programs; (3) provided financial support to enable current and emerging leaders to achieve their leadership vision through the WiSPP Future Leaders Awards; (4) and supporting future researchers with the Regional Girls Innovation Challenge which provided high school students with the opportunity to explore STEMM careers and the journey of scientific discovery.

Impact: WiSPP advocacy in collaboration with key strategic partners was successful in: (1) developing an agreed set of gender equity metrics in 2016 and routinely collecting data from each of its five institutes to enable progress to be tracked over time and to design targeted interventions; (2) establishing the Cross Institute Task Force Initiative in 2018, which brought together 30 scientists and professional staff members from different institutes, levels, scientific backgrounds and genders who worked together over 6 months using an evidence-based approach to better understand the reasons for a lack of gender equity (GE) in medical research and to identify potential ways to improve GE in medical research leadership; (3) successfully applying for a government grant in 2021 to provide intensive grant support programs to support a total 144 early and mid-career researchers over 3 years to improve women's grant funding success; (4) launching the Respect in Research Project in 2022 with the Sex Discrimination Commissioner of Australia, a direct outcome of extensive industry consultations to inform and shape organizational policies, training protocols, and overall strategies to empower leaders at medical research institutes, enabling them to meet their legal obligations and to drive substantive, enduring change.

Challenges: As a not-for-profit organization, heavily reliant on volunteer support and the financial donations of the partner institutes, with minimal paid staff and a lack of clear or consistent funding there are issues with the long-term stability of the programs, advocacy and the organization as a whole.

Further reading:

[81]https://www.wispp.org.au.

[82]https://www.wispp.org.au/stories.

[83]https://www.wispp.org.au/initiatives.

for women through mentorship programs, tailored leadership opportunities and collective support through unions or associations. Grassroots-driven not-for-profit diversity and inclusion advocacy organizations led by STEMM and healthcare professionals, that are financially supported by organizations have been shown to be highly beneficial in enhancing the visibility, training and promotion of women leaders (Case study 3).

Organizations driving gender equity include not only academic institutions and healthcare providers but also professional societies and funding bodies (Box 1). Professional societies can play a vital role by establishing diversity and inclusion committees to promote grassroots initiatives with discipline specific goals and to develop mentorship programs to connect women with senior leaders and peers. Equitable representation at conferences can be achieved through diversity reporting to improve women participation and visibility, which can be further improved through carer travel grants. Funding bodies can contribute by prioritizing funding for women scientists, including the use of quotas to ensure equal numbers of grants and funding amounts for women- and men-led research, a measure recently applied in Australia (Case study 4). Improved guidelines to evaluate career disruptions relative to opportunity, the provision of meaningful unconscious bias training for peer review panels and the introduction of caps on individual funding limits can all help to distribute resources more equitably. To effect meaningful change, leaders in healthcare and STEMM must intentionally promote gender-transformative policies that target systemic barriers, as these are the foundation for strong and equitable health systems.

Intersectionality to drive solutions

Traditionally, research of women in leadership has examined individual aspects of identity, such as gender or race, in isolation. However, growing recognition of the complexity of diverse identities within the workplace presents an opportunity to explore how cultural and

Case study 4. *Advocating for quotas and equal grant funding for women and men*

Approach: Following national advocacy from numerous STEMM organizations, committees and individuals and an extensive national consultation process led by Professor Anne Kelso, CEO of the NHMRC in 2020, Australia's largest Government funding agency issued new special measures under the Sex Discrimination Act 1984 to address the continuing systemic disadvantage faced by women and non-binary researchers. The goal was to reduce the significant gender inequities in funding outcomes in both number of grants and amount awarded (between 2019 and 2021, men applicants received about 35% more grants and 67% more total funding (about $95 million extra per year) than women applicants) in its Investigator Grant scheme, and to award an equal number of grants and funding to men and women researchers applying for Leadership fellowships.

Experience: Application of these measures to the 2023 Investigator Grant scheme has led to near equal numbers of grants being awarded to women and men at the Leadership level and equal funded rates by gender at the Emerging Leadership level. Overall, it has led to women receiving $8 million more in funding than men (compared with receiving on average $73 million less each year in the first 4 years of the scheme).

Impact: Although the measures have only been through two funding cycles, there continues to be equal awarding of grants to women and men, ensuring more women are able to continue their research and retain competitiveness with male counterparts. This has enabled more women to establish their leadership capabilities and to improve their retention within STEMM to act as visible role models for future scientists.

Challenges: The true impacts of the special measure will not be felt for a number of decades. This measure only targets one of a number of compounding biases women researchers experience in addition to publications bias, promotion inequities and increased pastoral care and carer responsibilities.

Further reading:

[84]https://www.wghaustralia.org/news/stemm-the-flow-more-work-needed-to-support-women-in-medical-research.

[85]https://franklinwomen.com.au/app/uploads/2022/02/POSITION-PAPER_NHMRC_EQUITY-IN-AUSTRALIAN-STEMM-3.pdf.

[86]https://onlinelibrary.wiley.com/doi/10.1111/imcb.12568.

[87]https://www.nhmrc.gov.au/about-us/news-centre/nhmrc-investigator-grants-sets-standard-gender-equity.

[88]https://www.health.gov.au/ministers/the-hon-mark-butler-mp/media/gender-equity-achieved-for-major-379-million-health-research-grant-program.

ethnic diversity intersects with women's leadership experiences.[72] Intersectionality offers a valuable framework for understanding how overlapping forms of discrimination and marginalization hinder women leaders and reveal the power structures that shape their experiences both in the workforce and beyond. This approach reveals how multiple dimensions of identity including gender, ethnicity, class, ability and sexuality interact to perpetuate underrepresentation and social inequity, and the need for these lenses to be incorporated into new models of equity.[73] Intersectionality is a framework that can help to drive gender equity solutions by acknowledging that multiple forms of discrimination and oppression can impact people at the same time. This approach suggests that addressing disadvantage in one group may not address discrimination and marginalization experienced by all other groups equally. By identifying and addressing the systems that perpetuate inequality for all participants in healthcare and STEMM, intersectionality will ensure efforts to promote gender equity are inclusive and effective for all. Therefore, work to prevent gender-based inequality cannot be completed in isolation from work to address other forms of discrimination.

CONCLUSION

Women have the right to equality in decision-making roles. Achieving gender equality in leadership will provide both men and women with much-needed female role models and mentors. Ensuring women have equal access to leadership in healthcare will boost morale and reduce attrition among women health workers.

Evidence indicates that gender-equal leadership will deliver multiple benefits, including

- Health: strengthening health systems and improving decision-making
- Gender: empowering women through increased income and agency
- Economic: stronger health systems and the creation of new jobs to drive economic growth

Studies consistently show that women in politics prioritize social welfare, family policy and gender equality, suggesting that more women in health leadership would expand the agenda to include issues which contribute to gender inequality. It is estimated that achieving equal participation of women in health could increase global human capital wealth by 22%.[4] More broadly, enhancing women's leadership potential is a critical long-term investment for organizational success, improved health policy and national prosperity.

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AUTHOR CONTRIBUTIONS

Jessica G Borger: Conceptualization; resources; writing – original draft; writing – review and editing. **Rhea J Longley:** Writing – review and editing. **Megan F Taylor:** Visualization; writing – review and editing. **Ruben Motrich:** Visualization. **Jennifer AE Payne:** Writing – review and editing. **Roslyn A Kemp:** Writing – review and editing.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Gender inequality index (GII). United Nations Development Programme: https://hdr.undp.org/data-center/thematic-composite-indices/gender-inequality-index#/indicies/GII. Accessed December 16, 2024.
2. Goal 5: Achieve gender equality and empower all women and girls. United Nations: Sustainable Development Goals. https://www.un.org/sustainabledevelopment/gender-equality/#:~:text=At%20the%20current%20rate%2C%20it,achieve%20equal%20representation%20in%20national. Accessed December 16, 2024.

3. Bona A, Ahmed R, Falvo L, *et al*. Closing the gender gap in medicine: the impact of a simulation-based confidence and negotiation course for women in graduate medical education. *BMC Med Educ* 2023; **23**: 243.
4. Mousa M, Boyle J, Skouteris H, *et al*. Advancing women in healthcare leadership: a systematic review and meta-synthesis of multi-sector evidence on organisational interventions. *EClinicalMedicine* 2021; **39**: 101084.
5. Dhatt R, Keeling A. Women in global health are the labor, but not leaders. Time's up: Harvard Public Health. https://harvardpublichealth.org/equity/women-in-global-health-are-the-labor-but-not-leaders-times-up/. Accessed December 16, 2024.
6. The State of Women and Leadership in Global Health. Women in Global Health. https://womeningh.org/wp-content/uploads/2023/03/The-State-of-Women-and-Leadership-in-Global-Health.pdf. Accessed December 16, 2024.
7. Gender representation in universities: 2014 vs 2018. Science in Australia Gender Equity (SAGE). https://sciencegenderequity.org.au/resources/blog/gender-representation-in-universities-2014-vs-2018/. Accessed December 16, 2024.
8. Despite progress, adolescent girls continue to bear the brunt of the HIV epidemic with 98,000 new infections in 2022. Unicef. https://www.unicef.org/press-releases/despite-progress-adolescent-girls-continue-bear-brunt-hiv-epidemic-98000-new. Accessed December 16, 2024.
9. Fairweather D, Rose NR. Women and autoimmune diseases. *Emerg Infect Dis* 2004; **10**: 2005–2011.
10. Rheumatoid arthritis. World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/rheumatoid-arthritis. Accessed December 16, 2024.
11. Ellis R. Why multiple sclerosis affects more women than men. WebMD. https://www.webmd.com/multiple-sclerosis/ms-affects-women-more-than-men. Accessed December 16, 2024.
12. Beam CR, Kaneshiro C, Jang JY, Reynolds CA, Pedersen NL, Gatz M. Differences between women and men in incidence rates of dementia and Alzheimer's disease. *J Alzheimers Dis* 2018; **64**: 1077–1083.
13. Women more likely to die after heart attack than men. European Society of Cardiology. https://www.escardio.org/The-ESC/Press-Office/Press-releases/Women-more-likely-to-die-after-heart-attack-than-men. Accessed December 16, 2024.
14. Casale R, Atzeni F, Bazzichi L, *et al*. Pain in women: a perspective review on a relevant clinical issue that deserves prioritization. *Pain Ther* 2021; **10**: 287–314.
15. NIH Inclusion Outreach Toolkit: How to Engage, Recruit, and Retain Women in Clinical Research. National Institute of Health. https://orwh.od.nih.gov/toolkit/recruitment/history. Accessed December 16, 2024.
16. Carey JL, Nader N, Chai PR, Carreiro S, Griswold MK, Boyle KL. Drugs and medical devices: adverse events and the impact on women's health. *Clin Ther* 2017; **39**: 10–22.
17. Nowogrodzki A. Clinical research: inequality in medicine. *Nature* 2017; **550**: S18–S19.
18. Women's Health Outcomes. UK Parliament. https://hansard.parliament.uk/lords/2021-07-08/debates/93A403D9-C1B5-4820-AE5D-39C14AC99890/Women%E2%80%99SHealthOutcomes. Accessed December 16, 2024.
19. Promoting Safe & Effective Drugs for 100 years. FDA Consumer magazine. https://www.fda.gov/about-fda/histories-product-regulation/promoting-safe-effective-drugs-100-years. Accessed December 16, 2024.
20. Fox M. Despite decades of promises, health research still overlooks women. *The Guardian*. https://www.theguardian.com/science/2023/nov/20/women-health-research-jill-biden-white-house. Accessed December 16, 2024.
21. Southall JR. Disparities persist in clinical trial leadership across specialties. *Healio*. https://www.healio.com/news/hematology-oncology/20231030/disparities-persist-in-clinical-trial-leadership-across-specialties#:~:text=Researchers%20determined%20the%20gender%20for,compared%20with%20men%20at%2063.5%25. Accessed December 16, 2024.
22. Waldhorn I, Dekel A, Morozov A, *et al*. Trends in women's leadership of oncology clinical trials. *Front Oncol* 2022; **12**: 885275.
23. Downs JA, Reif LK, Hokororo A, Fitzgerald DW. Increasing women in leadership in global health. *Acad Med* 2014; **89**: 1103–1107.
24. Luong VTT, Ho C, Aedo-Lopez V, Segelov E. Gender profile of principal investigators in a large academic clinical trials group. *Front Surg* 2022; **9**: 962120.
25. Waldhorn I, Bomze D, Ben-Aharon I, *et al*. Gender gap in leadership of clinical trials. *JAMA Intern Med* 2023; **183**: 1406–1408.
26. Gomez LE, Bernet P. Diversity improves performance and outcomes. *J Natl Med Assoc* 2019; **111**: 383–392.
27. Newman TH, Parry MG, Zakeri R, *et al*. Gender diversity in UK surgical specialties: a national observational study. *BMJ Open* 2022; **12**: e055516.
28. Chowdhary M, Chowdhary A, Royce TJ, *et al*. Women's representation in leadership positions in academic medical oncology, radiation oncology, and surgical oncology programs. *JAMA Netw Open* 2020; **3**: e200708.
29. Lim WH, Wong C, Jain SR, *et al*. The unspoken reality of gender bias in surgery: a qualitative systematic review. *PLoS One* 2021; **16**: e0246420.
30. Heisler CA, Miller P, Stephens EH, Ton J, Temkin SM. Leading from behind: paucity of gender equity statements and policies among professional surgical societies. *Am J Surg* 2020; **220**: 1132–1135.
31. Denby KJ, Szpakowski N, Silver J, Walsh MN, Nissen S, Cho L. Representation of women in cardiovascular clinical trial leadership. *JAMA Intern Med* 2020; **180**: 1382–1383.
32. Shalit A, Vallely L, Nguyen R, *et al*. The representation of women on Australian clinical practice guideline panels, 2010-2020. *Med J Aust* 2023; **218**: 84–88.
33. Lombardi ME, Marulanda K, McGinigle KL. Promoting diversity and inclusion in vascular surgery science: challenges and opportunities. *JVS Vasc Insights* 2024; **2**: e100127.
34. Cevik M, Haque SA, Manne-Goehler J, *et al*. Gender disparities in coronavirus disease 2019 clinical trial leadership. *Clin Microbiol Infect* 2021; **27**: 1007–1010.

35. Muric G, Lerman K, Ferrara E. Gender disparity in the authorship of biomedical research publications during the COVID-19 pandemic: retrospective observational study. *J Med Internet Res* 2021; **23**: e25379.
36. Sehgal NKR, Brownstein JS, Majumder MS, Tuli G. US COVID-19 clinical trial leadership gender disparities. *Lancet Digit Health* 2023; **5**: e109–e111.
37. Liu X, Dunlop R, Allavena R, Palmieri C. Women representation and gender equality in different academic levels in veterinary science. *Vet Sci* 2021; **8**: 159.
38. Winchester HPM, Browning L. Gender equality in academia: a critical reflection. *J High Educ Policy Manag* 2015; **37**: e1034427.
39. She Figures 2018. European Commission. https://research-and-innovation.ec.europa.eu/knowledge-publications-tools-and-data/publications/all-publications/she-figures-2018_en. Accessed December 16, 2024.
40. Al-Busaidi IS, Sharif K, Hassan A. Gender, geographic, and socioeconomic representation in medical student journals: a cross-sectional analysis. *Cureus* 2021; **13**: e12838.
41. Amrein K, Langmann A, Fahrleitner-Pammer A, Pieber TR, Zollner-Schwetz I. Women underrepresented on editorial boards of 60 major medical journals. *Gend Med* 2011; **8**: 378-387.
42. Women Still Missing From Clinical Trial Leadership. American College of Cardiology. Available from https://www.acc.org/Latest-in-Cardiology/Articles/2022/03/12/01/42/Feature-Women-Still-Missing-From-Clinical-Trial-Leadership-acc-2022. Accessed December 16, 2024.
43. Deepening the debate on those still left behind. Unesco. 2022. https://www.unesco.org/gem-report/en/2022-gender-report. Accessed December 16, 2024.
44. Global Gender Gap Report 2023. World Economic Forum. https://www.weforum.org/publications/global-gender-gap-report-2023/in-full/gender-gaps-in-the-workforce/. Accessed December 16, 2024.
45. Taylor KS, Lambert TW, Goldacre MJ. Career progression and destinations, comparing men and women in the NHS: postal questionnaire surveys. *BMJ* 2009; **338**: b1735.
46. Ceci SJ, Williams WM, Barnett SM. Women's underrepresentation in science: sociocultural and biological considerations. *Psychol Bull* 2009; **135**: 218–261.
47. Seifert TA, Umbach PD. The effects of faculty demographic characteristics and disciplinary context on dimensions of job satisfaction. *Res High Educ* 2007; **49**: 357–381.
48. Cassells R, Duncan AS. Gender equity insights 2019: breaking through the glass ceiling, Bankwest Curtin Economics Centre Report series 2019. https://bcec.edu.au/publications/gender-equity-insights-2019-breaking-through-the-glass-ceiling/. Accessed January 23, 2025.
49. Coe IR, Wiley R, Bekker LG. Organisational best practices towards gender equality in science and medicine. *Lancet* 2019; **393**: 587–593.
50. Betron M, Bourgeault I, Manzoor M, *et al.* Time for gender-transformative change in the health workforce. *Lancet* 2019; **393**: e25–e26.
51. Cassells R, Duncan AS. Gender Equity Insights 2020: Delivering the Business Outcomes. BCEC|WGEA Gender Equity Series: Bankwest Curtin Economics Centre, Curtin Business School. 2020. https://www.wgea.gov.au/sites/default/files/documents/BCEC%20WGEA%20Gender%20Equity%20Insights%202020%20Delivering%20the%20Business%20Outcomes_WEB_FINAL.pdf. Accessed January 23, 2025.
52. Ghebreyesus TA. Female health workers drive global health. World Health Organisation. https://www.who.int/news-room/commentaries/detail/female-health-workers-drive-global-health. Accessed December 16, 2024.
53. Wood J. 3 things to know about women in STEM. World Economic Forum. https://www.weforum.org/stories/2020/02/stem-gender-inequality-researchers-bias/#:~:text=On%20average%2C%20around%2030%25%20of,and%20often%20receive%20less%20pay. Accessed December 16, 2024.
54. Borger JG. How COVID-19 risks reversing the gender equity gains made by women in STEM. Women's Agenda. https://womensagenda.com.au/latest/how-covid-19-risks-reversing-the-gender-equity-gains-made-by-women-in-stem/. Accessed December 16, 2024.
55. Borger JG. Should we all draw up Covid CVs?: Times Higher Education. https://www.timeshighereducation.com/opinion/should-we-all-draw-covid-cvs. Accessed December 16, 2024.
56. Alston SJ. Equality, justice and gender: barriers to the ethical university for women. *Ethics Educ* 2011; **6**: 279–291.
57. Bakker MM, Jacobs MH. Tenure track policy increases representation of women in senior academic positions, but is insufficient to achieve gender balance. *PLoS One* 2016; **11**: e0163376.
58. McDermott M, Gelb DJ, Wilson K, *et al.* Sex differences in academic rank and publication rate at top-ranked US neurology programs. *JAMA Neurol* 2018; **75**: 956–961.
59. Casad BJ, Franks JE, Garasky CE, *et al.* Gender inequality in academia: problems and solutions for women faculty in STEM. *J Neurosci Res* 2021; **99**: 13–23.
60. Ovseiko PV, Greenhalgh T, Adam P, *et al.* A global call for action to include gender in research impact assessment. *Health Res Policy Syst* 2016; **14**: 50.
61. Maliniak D, Powers R, Walter BF. The gender citation gap in international relations. *Int Organ* 2013; **67**: 889–922.
62. Carnes M, Geller S, Fine E, Sheridan J, Handelsman J. NIH Director's Pioneer awards: could the selection process be biased against women? *J Womens Health (Larchmt)* 2005; **14**: 684–691.
63. Magua W, Zhu X, Bhattacharya A, *et al.* Are female applicants disadvantaged in National Institutes of Health peer review? Combining algorithmic text mining and qualitative methods to detect evaluative differences in R01 Reviewers' critiques. *J Womens Health (Larchmt)* 2017; **26**: 560–570.
64. Bornmann L, Mutz R, Hans-Dieter D. Gender differences in grant peer review: a meta-analysis. *J Inf Secur* 2007; **1**: 226–238.

65. Brower A, James A. Research performance and age explain less than half of the gender pay gap in New Zealand universities. *PLoS One* 2020; **15**: e0226392.
66. van der Lee R, Ellemers N. Gender contributes to personal research funding success in The Netherlands. *Proc Natl Acad Sci U S A* 2015; **112**: 12349–12353.
67. Witteman HO, Hendricks M, Straus S, Tannenbaum C. Are gender gaps due to evaluations of the applicant or the science? A natural experiment at a national funding agency. *Lancet* 2019; **393**: 531–540.
68. Kingsley I, Slavich E, Harvey-Smith L, Johnston EL, Williams LA. Grant Leadership is Key to Gender Equity. 2024. https://osf.io/preprints/osf/8rzux. Accessed January 23, 2025.
69. Zawaira T, Clance M, Chisadza C. Social institutions, gender attitudes and female labour force participation in sub-Saharan Africa. *S Afr J Econ* 2022; **91**: 186–213.
70. The State of Women's Economic Empowerment in the Indian Ocean Rim. Country Snapshot: India. UN Women. https://interactive.unwomen.org/multimedia/infographic/economicempowermentindianocean/en/india.html. Accessed December 16, 2024.
71. Shannon G, Jansen M, Williams K, *et al*. Gender equality in science, medicine, and global health: where are we at and why does it matter? *Lancet* 2019; **393**: 560–569.
72. Sanchez-Hucles JV, Davis DD. Women and women of color in leadership: complexity, identity, and intersectionality. *Am Psychol* 2010; **65**: 171–181.
73. Nunez A-M, Rivera J, Hallmark T. Applying an intersectionality lens to expand equity in the geosciences. *J Geosci Education* 2019; **68**: 97–114.
74. Borger JG, Lawlor K, Quinn K. Applying the Gendered Lens to a Post-COVID Academia: An Australian Perspective. Immunology News: *British Society of Immunology*; 2020. https://www.immunology.org/sites/default/files/202308/Immunology_News_September%202020_web_FINAL.pdf.Accessed. January 23, 2025.
75. Lee KS, Ono H. Only one developed country does not have guaranteed paid maternity leave. *World Economic Forum*. https://www.weforum.org/stories/2022/04/paid-family-leave-makes-people-happier-global-data-shows/. Accessed December 16, 2024.
76. Fleming S. 5 things to know about new fathers and paternity leave. *World Economic Forum*. https://www.weforum.org/stories/2021/06/paternity-leave-fathers-day/. Accessed December 16, 2024.
77. STEMPals website. STEMPals. https://stempals.org.au/. Accessed December 16, 2024.
78. What does a scientist look like? Generator start up champions curiosity in primary school students. Monash Innovation (Monash University). https://www.monash.edu/monash-innovation/news/what-does-a-scientist-look-like-monash-university-generator-start-up-champions-curiosity-in-primary-school-students. Accessed December 16, 2024.
79. Gray M, Bhaskaran M. Five lessons from our women only recruitment round. Australian Research Council Centre of Excellence for Transformative Meta-Optical Systems (TMOS). https://www.tmos.org.au/idea/five-lessons-from-our-women-only-recruitment-round/. Accessed December 16, 2024.
80. Byrne D. How we boosted female faculty numbers in male-dominated departments. *Nature* 2024. https://doi.org/10.1038/d41586-024-00212-7. Online ahead of print. https://www.nature.com/articles/d41586-024-00212-7. Accessed January 23, 2025.
81. Women in Science Parkville Precinct (WiSPP). WiSPP. https://www.wispp.org.au. Accessed December 16, 2024.
82. Women in Science Parkville Precinct: Stories. WiSPP. https://www.wispp.org.au/stories. Accessed December 16, 2024.
83. Women in Science Parkville Precinct: Initiatives. WiSPP. https://www.wispp.org.au/initiatives. Accessed December 16, 2024.
84. Borger JG. STEMM the flow: More work needed to support women in medical research. Women in Global Health Australia. https://www.wghaustralia.org/news/stemm-the-flow-more-work-needed-to-support-women-in-medical-research. Accessed December 16, 2024.
85. Purton L, Lawlor K, Borger JG, *et al*. Ending an exodus: how NHMRC gendered funding outcomes are contributing to the lack of retention of women in STEMM. *Franklin Women*. https://franklinwomen.com.au/app/uploads/2022/02/POSITION-PAPER_NHMRC_EQUITY-IN-AUSTRALIAN-STEMM-3.pdf. Accessed December 16, 2024.
86. Borger JG, Purton LE. Gender inequities in medical research funding is driving an exodus of women from Australian STEMM academia. *Immunol Cell Biol* 2022; **100**: 674–678.
87. Wesselingh S. NHMRC investigator grants sets the standard for gender equity. National Institute of Health and Medical Research Council. https://www.nhmrc.gov.au/about-us/news-centre/nhmrc-investigator-grants-sets-standard-gender-equity. Accessed December 16, 2024.
88. Butler M. Gender equity achieved for major $379 million health research grant program. Ministers: Department of Health and Aged Care. https://www.health.gov.au/ministers/the-hon-mark-butler-mp/media/gender-equity-achieved-for-major-379-million-health-research-grant-program. Accessed December 16, 2024.