Progress Toward Gender Equality in Research & Innovation – 2024 Review

An in-depth analysis of research participation, career progression and research contributions across the globe

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Foreword

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"One never notices what has been done; one can only see what remains to be done."
I grew up listening to inspiring stories about Marie Curie, two-time Nobel prize winner, from my engineer grandfather in Turkey. Her words capture profoundly the essence of our latest report, *Progress Towards Gender Equality in Research & Innovation – 2024 review.*

In putting together this comprehensive analytics report, we sought to summarise the advances as well as the persistent and remaining challenges experienced by women researchers with a data-driven approach across 17 indicators, two decades and 18 countries and 2 regions. Our aim is to provide academic leaders, funders and policymakers data-led insights that inform action to accelerate the pace of change and advance gender equality in the research and innovation ecosystem.

Over the past 5 years, I had the privilege to serve as Elsevier's first woman CEO in its 144-year history. At Elsevier, we place inclusion and diversity at the heart of the way we work, think and run our business, supported by the collective passion and hard work of the research and healthcare communities we serve and of our 9,000 colleagues. Along this journey, we had many moments of joy as we celebrated progress but also moments of frustration by the slow pace of change and how much work remains to be done.

Together with the communities that we serve, we use our content, data, analytics, networks, and the unique contributions of the Elsevier Foundation, to advance inclusive research and inclusive healthcare. We are guided in our efforts by our Inclusion & Diversity Advisory Board of distinguished research leaders from around the world who bring deep expertise and rich perspectives in research, health, policy and workforce development to whom I am very grateful. We strive to move the needle across all dimensions of inclusion and diversity through accountability and practical action, led by the dedicated group of colleagues who serve on the Elsevier Gender Equity Taskforce.

Over the last five years, we increased the diversity of our editorial boards, conference speakers and our own senior leadership. We worked with the wider publishing industry to establish self-reported gender, race and ethnicity schemas for editors, authors and peer-reviewers to measure and drive progress. We raised awareness and compliance around factoring sex and gender dimensions into the way research is conducted and reported. We also worked to address long-standing inequities in healthcare with new digital health products such as the first ever three-dimensional female anatomy model for medical education.

There is progress, but it is slow. At the current pace of change, equality remains too far away and further action is needed to accelerate change. Our hope is that the rich insights in this report, together with the extensive data available on the companion Gender Dashboard, will help stimulate dialogue, sharing of best practice and inform targeted interventions to support women researchers and innovators.

Taking our inspiration from Marie Curie and the legions of talented women scientists before and since, we have sought to both "notice what has been done" and what "remains to be done". We invite you to share your feedback and thoughts with us as we continue to work with all stakeholders in the research community towards the goal of achieving greater inclusion, diversity and equality in research and innovation.

Executive summary

In this report, we explore the progress made over the past two decades toward achieving equal participation by women in research and innovation. By contributing to a greater understanding of the current landscape, this report intends to illuminate pathways forward, inform policymaking and contribute to the pursuit of gender diversity and equal opportunities in the research workforce.

Context

The global research and innovation community is making progress towards full and equal participation of women.[1] Twenty years ago, women made up only 29% of researchers. Since then, the proportion of women among active researchers has steadily increased and reached 41% in 2022, though obstacles remain.

Over the past years, a growing chorus of voices has been urging researchers to tackle the world's most complex and important problems, such as the climate crisis and sustainable development. To address these challenges, it's crucial to embrace diverse perspectives and leverage the entire talent pool.

In this context, we have undertaken a data-driven analysis of gender diversity in research, building on our prior reporting and analysis, such as the landmark 2020 report *The Researcher Journey Through a Gender Lens*. We broaden our analytical scope to investigate gender together with field of study, engagement in Sustainable Development Goals (SDGs) research and career stage.

Our analysis draws on authorship within publication data from Scopus stretching back over more than two decades. Eighteen countries were selected for inclusion, analyzed individually along with the 27 countries of the European Union (EU-27) and the World as a whole.

Report objectives

1) Assess the representation of women in research and innovation and changes over time, across disciplines and career cohorts, in a global context and for the 18 countries analyzed.
2) Drawing inspiration from the Academic Evaluation Framework[2] developed by Elsevier in collaboration with the higher education community, paint a fuller picture of the role of gender in the global research and innovation ecosystem through new insights in areas such as grant applications, open access publication, research interdisciplinarity and multidisciplinarity, SDG research, research and societal impact, and innovation as measured by patent filings.
3) Provide rich data and insights to the global research community—government, funders, universities and research institutions, policymakers, media and researchers themselves—to advance gender equality in research and innovation by informing evidence-based policy.

A publicly available online dashboard, accessible at https://www.elsevier.com/insights/gender-and-diversity-in-research, accompanies this report.

[1] Gender is inferred for authors using NamSor, which treats gender as a binary. This presents a limitation as we cannot infer, for example, 'non-binary'.
[2] Details about Elsevier's Academic Evaluation Framework: The Future of Evaluation: Emerging Consensus on a More Holistic System.

The interactive dashboard permits exploration of the data beyond the figures and analysis in this report. It enables deeper dive analyses combining various facets and dimensions across career cohorts, geographies and research disciplines. The dashboard also contains the detailed methodology used in the report.

Methodology

This report utilizes extensive bibliometric, funding, and patent data, employing a comprehensive array of both individual and composite indicators. While some methodological details are discussed within each respective section and in the brief methodology section, a complete description of the methodology is accessible via the interactive dashboard that accompanies this report.

Key findings

The findings presented here begin with an overview of researcher participation and funding access, examining inputs into the research ecosystem. This is followed by indicators of research culture, including multi- and interdisciplinarity and open access publication rate. The overview then continues with research outputs, such as publication authorship and patent filings, and concludes with outcomes and impact metrics, including contributions to the UN Sustainable Development Goals (SDGs) and broader societal impacts. This approach aligns with the Academic Evaluation Framework, which is emerging as a consensus view of assessment of the academic landscape.

Although progress in gender representation is evident, these data paint a complex picture of women's contributions to research and innovation.

- **Women have made gains in the last two decades, and as of 2022, represent 41% of all active researchers. However, this does not mean all fields are close to parity: in multiple STEM disciplines women's participation is much lower.** Women's representation in research has increased across all cohorts, from early-career to advanced-career researchers. It is also important to note that achieving parity in participation does not necessarily equate to achieving equality in opportunities, such as funding and representation in senior positions.

Grant funding to women is increasing, though slowly.

- Of the countries with sufficient grant data available for analysis, **the average share of women among grant awardees increased from 29% in 2009 to 37% in 2022**. The largest increases were for the Netherlands, Denmark, the United Kingdom, France, Canada and Portugal. Although women gained more grant awards, these gains were not sufficient to keep pace with the growing proportion of women active researchers.

Women researchers perform well on indicators of research culture, such as multidisciplinarity.

- Multidisciplinary research, in which researchers from diverse disciplinary backgrounds collaborate, is considered important to solving complex global challenges**. Publications involving women across all disciplines have remained slightly more multidisciplinary** than those from men and this pattern holds across most of the broad categories of sciences, as well as over time.

Output measures show differences, and point to areas where change is needed.

- While women's participation in research has notably increased, **across all career cohorts fewer papers involving women are being published than papers involving men and this gap has not narrowed over two decades**. This may point to systemic hurdles that prevent women from publishing as frequently as men or to gender differences in publishing behaviors.
- **Publications authored by men are, on average, cited more** than those authored by women, though the gap tends to diminish as careers advance. Citation metrics are widely used in bibliometrics as a proxy for excellence and relevance of research.
- **Women file vastly fewer patent applications than men.** The growing share of women in research has not led to a similar share of women in innovation, the arena in which scientific research is transformed and applied to industry and commerce. As of 2022, **three-quarters of patent applications are filed either by men alone or by teams consisting only of men**. Nearly all patent

filing teams (97%) have at least one man on them. In contrast, **just 3% of patent applications as of 2022 are filed by teams consisting only of women.** Of the countries examined, Germany had the smallest share of patent applications filed by women.

When examining outcomes, publications involving women perform especially well on indicators relevant to societal issues and are more likely to be cited in policy documents.

- **Women comprise the majority of active researchers on some United Nations Sustainable Development Goals (SDGs)**, including education (SDG 4), gender equality (SDG 5), reduced inequalities (SDG 10) and peace and justice (SDG 16).
- **Advanced-career women researchers are outside of the parity zone[3] (40–60% representation) across 13 SDGs compared to only 2 SDGs for earlier-career women,** highlighting how critical it will be to have policies in place to retain earlier-career women in these areas to achieve greater parity in the future.
- **Publications involving women are more likely to be cited in policy documents** than publications by men. This holds across Health Sciences and Physical Sciences as measured by year-normalized[4] policy citation scores. This holds across all analyzed countries in 2018–2022 except for Argentina.

Takeaways and areas of action

Insights from this report support the following recommendations to further advance gender equality and greater diversity in research and innovation.

1. Accelerate commitments and actions towards greater gender equality in research

Whilst it is encouraging to see continued progress, progress is still too slow and, at the current pace of change, equality remains unacceptably far away. We need to accelerate action now to build and sustain diverse research teams.

2. Prioritize retention of early-career women researchers into mid and advanced career stages

Data continue to show a clear decline in percentage of women authors who reach mid-career stage. Academic leaders and funders should take actions to retain early-career women and help them progress in their careers in the research and innovation ecosystem. These can include driving an inclusive culture by addressing unconscious bias, actively providing mentoring and coaching, introducing policies that support women through life changes such as parenthood, and aiding them as they seek access to research funding.

3. Develop incentive structures to help women play an equal part in the full research and innovation value chain

The persistence of gender disparities in STEM fields and in patent applications highlights the need for strategic interventions to drive change in these innovation related areas. These can include financial incentives, preferential funding opportunities, and targeted training for women on how to translate research to innovation and patents. Implementing policies that remove barriers to participation in the full value chain of research (including patents and IP) and that reward and prioritize gender-diverse teams can significantly enhance women's contribution to innovation, and technological and economic advancement.

4. Apply a broad range of indicators to measure research effectiveness, including societal and policy impact

We advocate for a holistic approach to evaluating research, one that moves beyond traditional bibliometrics such as citations and includes broader indicators of excellence. This approach should include qualitative and quantitative data based on factors such as research culture and societal and policy impact to capture more fully researchers' contributions.

As part of this, we need to adopt a longer time frame in evaluation, as the transformation of scientific knowledge into policy and patent citations can be slow, taking up to 10 years.

[3] Also referred to as "gender balance." For the definition of the parity zone, see the UNIFEM report Who Answers to Women? (2008).
[4] The share of publications cited in policy documents decreases closer to the present time because policy citations can take a long time to accrue. Therefore, policy citation scores are normalized annually to account for this effect.

5. Continue to collect and report inclusion and diversity data to monitor progress, identify gaps, evaluate policies, and drive accountability

This report affirms the critical role of data in advancing gender equality. Evidence-based insights help to identify and address persistent disparities, such as in participation in STEM disciplines, in access to funding, and in authorship, citation and patent application patterns. Continued collection and reporting of data on the key indicators not only helps us to focus on areas to tackle but is also critical for driving accountability.

Contents

Introduction

Solving the critical societal challenges of our time requires the full contribution of all researchers in the global research and innovation ecosystem. Women's participation in research is greater than ever before. Although representation and research performance are on the rise, there is still much to be done to attain full parity.

Gender equality in research allows society to benefit from the diverse range of perspectives, ideas, and approaches that men and women bring to their work. This broad representation of views and experiences is crucial for tackling complex problems. Gender-diverse teams produce more novel and higher-impact scientific ideas and remain more reflective of society itself, making it more likely that the innovative solutions they develop will be equitable, inclusive, and effective.

Elsevier has been measuring and reporting on gender in research since 2015 as part of our commitment to advancing inclusion and diversity in research. Our aim is to provide academic leaders, funders and policymakers with the evidence base to inform progress, policies and data-led action.

This report is structured around the Academic Evaluation Framework to thoroughly examine key components of the research ecosystem. To complement the report, Elsevier's accompanying Gender Dashboard[5] also provides an invaluable tool for researchers to investigate the data more closely.

Chapter 1 (Research and grant participation) examines the input side of research, focusing on the rates of women participating in research by career cohort, discipline and geography, and the often-uneven access of women researchers to funding.

Chapter 2 (Research culture) explores the knowledge creation process, emphasizing the importance of multidisciplinarity, interdisciplinarity, and open access publishing in fostering an inclusive environment.

Chapter 3 (Research output) scrutinizes patterns of research authorship, academic impact, and patent output, shedding light on disparities in authorship and recognition within the research community.

Lastly, **Chapter 4 (Research outcomes and impact)** examines the broader societal implications of research, examining contributions towards achieving the Sustainable Development Goals (SDGs) and alternative metrics such as policy and patent citations as well as media and Wikipedia mentions.

In addressing the challenges faced by women in science, we must address disparities across all research stages. Gender equality, of course, is more than women and men participating in research in equal numbers. It implies the equal representation of women in senior leadership posts and at the highest echelons of academia.

Still, with this report, we hope to provide an overview of the current state of affairs, drawing on robust data. Through data-driven insights in each chapter, this report aims to catalyze efforts towards advancing gender equality in research and innovation, ensuring sustained progress and accelerated attainment of full parity.

[5] https://www.elsevier.com/insights/gender-and-diversity-in-research

Methodological guidance

This section provides a summary of the key methodological aspects of the study relating to gender inference and inclusion of authors, grant awardees and patent inventors. Additional details are available within the respective sections. For a comprehensive overview of the methodology and indicators, please refer to the dashboard at www.elsevier.com/insights/gender-and-diversity-in-research.

Gender inference of authors, grant awardees and patent inventors

We used NamSor to infer the gender of authors, grant awardees and inventors. NamSor treats gender as a binary variable, inferring gender only as "woman" or "man". Individuals included in the analysis were limited to those for whom a first name could be determined, and a gender could be predicted based on the latest version of the NamSor API (i.e., surpassing a calibrated probability of 0.85).

Identification of active authors/researchers

For bibliometric analysis, we focused on active authors, defined as those publishing at least two peer-reviewed articles within a five-year period. This threshold ensured inclusion of consistently active researchers. Active authors for a specific period were those linked to at least two publications during that period. Due to our grouping by five-year periods, the report's annual data are based on 5-year moving windows, reported as the last year of each window. For example, data for 2002 reflect the 1998–2002 period.

Gender attribution in the analysis

When we reference "women's research" or "men's research," it is important to clarify that these terms do not imply that the research is exclusively authored by individuals of a single gender. Rather, these terms are used to denote all research by women or men authors, which can include publications authored collaboratively by mixed-gender teams. For example, when we state that "45% of all content authored by women was published Gold open access," we mean that, across all women authors, the average share of Gold open access publications out of their total publications (including in mixed-gender teams) was 45%. This approach relies on full counting, wherein each author of a publication receives full credit for that publication. The only sections in which fractional counting is used are Section 3.1 (Research authorship) and Section 3.2 (Academic impact), where each author in a publication is given a fraction of the publication, based on the number of authors (e.g. each author of a publication with 5 authors is credited with 0.2 publications).

Selection of countries included in the analysis

For bibliometric analysis, the selection of countries was made to ensure representativity on a global scale as well as minimum levels of data to ensure robust analyses. Selected countries have at least 4,000 active authors per period. To ensure that the prediction of gender based on name was similar across countries included in the report, we limited countries to those for which a gender could be inferred for at least 85% of Author IDs. When referring to data for the entire World, we used all Author IDs for which gender could be inferred. For grants analysis, awardees were assigned to a country based on the location of the funding agency. We limited the analyses to those countries selected for the bibliometric analysis with at least 1,000 awardees during the period 2018-2022. Countries included in the patent analysis are the same as those selected for the bibliometric analysis.

Chapter 1

Research and grant participation

1.1 Research participation

Women's participation in research has increased over the past two decades, reaching the parity zone[6] (40–60%) for the first time in 2022, with 41% of all active researchers. However, disparities persist across STEM fields, advanced-career cohorts, and several geographies.

Why is this important?

Women's participation in research is not only critical for promoting an equitable society, but also for fostering diversity of perspectives, comprehensive and balanced findings, innovation, and responsiveness to societal needs.

How is research participation measured?

To assess women's involvement in research, we analyzed the proportion of men and women active researchers, defined as those publishing at least twice in a five-year period.

Women's representation in research has increased steadily over the past 20 years, reaching parity for the first time in 2022 (FIGURE 1-1). While this is a significant milestone, differences remain across career stages (FIGURE 1-2), with advanced-career women researchers (21+ years of publication record) comprising just 27% of this most established cohort in 2018–2022. Therefore, recent gains made by women are mostly attributable to early-career women researchers entering the research ecosystem.

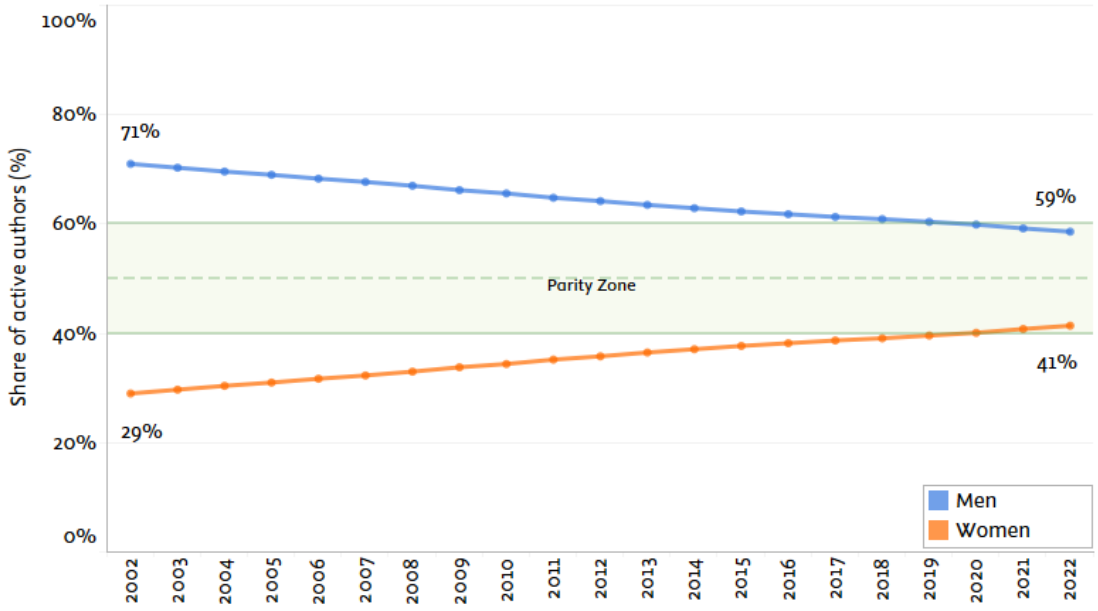

FIGURE 1-1
Trend in the share of women and men active researchers across all countries included in the analysis.
Source: Scopus and NamSor data

[6] Also referred to as "gender balance." For the definition of the parity zone, see the UNIFEM report Who Answers to Women? (2008).

There are known barriers that hinder women's career development in research. Maintaining work-life balance, combating gender bias and navigating institutional and funding disparities all pose significant challenges. To support progress in gender diversity, policies must prioritize retaining earlier-career women in research.

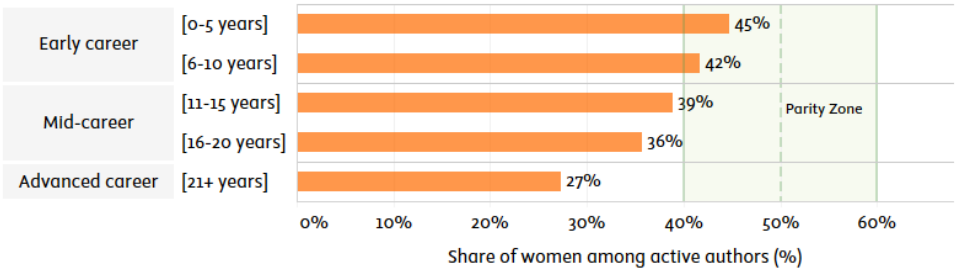

FIGURE 1-2
Proportion of women researchers by career cohort in 2018-2022.
Source: Scopus and NamSor data

Not only are there differences in representation across career stages, but also across disciplines as shown in FIGURE 1-3 on the basis of the Scopus All-Science Journal Classification (ASJC) categories. While women are well represented in Health Sciences, such as Nursing, Psychology, and Immunology and Microbiology, they remain underrepresented across multiple STEM fields.[7]

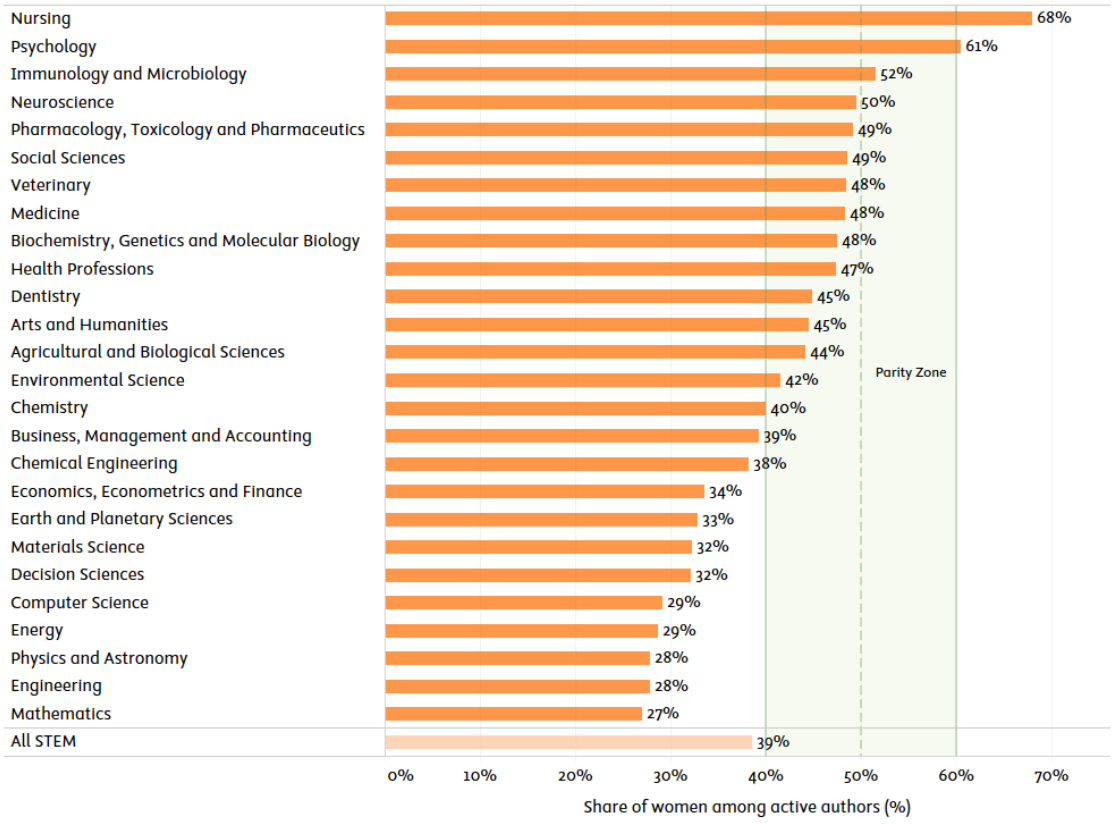

FIGURE 1-3
Proportion of women researchers by ASJC category in 2018–2022.
Source: Scopus and NamSor data

[7] In this report, STEM covers Biochemistry, Genetics and Molecular Biology, Chemical Engineering, Chemistry, Computer Science, Earth and Planetary Sciences, Engineering, Mathematics and Physics and Astronomy.

Geography is yet another critical factor that affects women's representation in research, likely due to differences in cultural norms and national policies in place to promote women's participation. FIGURE 1-4 reflects the situation in 2018–2022 across 18 countries, selected to ensure global representativity, while also having sufficiently high population sizes to extract meaningful data.

Among the selected countries, a pattern emerges for countries with Hispanic and Latin backgrounds taking all the top positions in terms of women's representation in academic research. In contrast, women make up less than a quarter (just 22%) of active researchers in Japan, 30% in Egypt, and 33% in India. Nevertheless, all selected countries without exception are making progress toward parity as indicated by Compound Annual Growth Rate (CAGR) throughout the period.

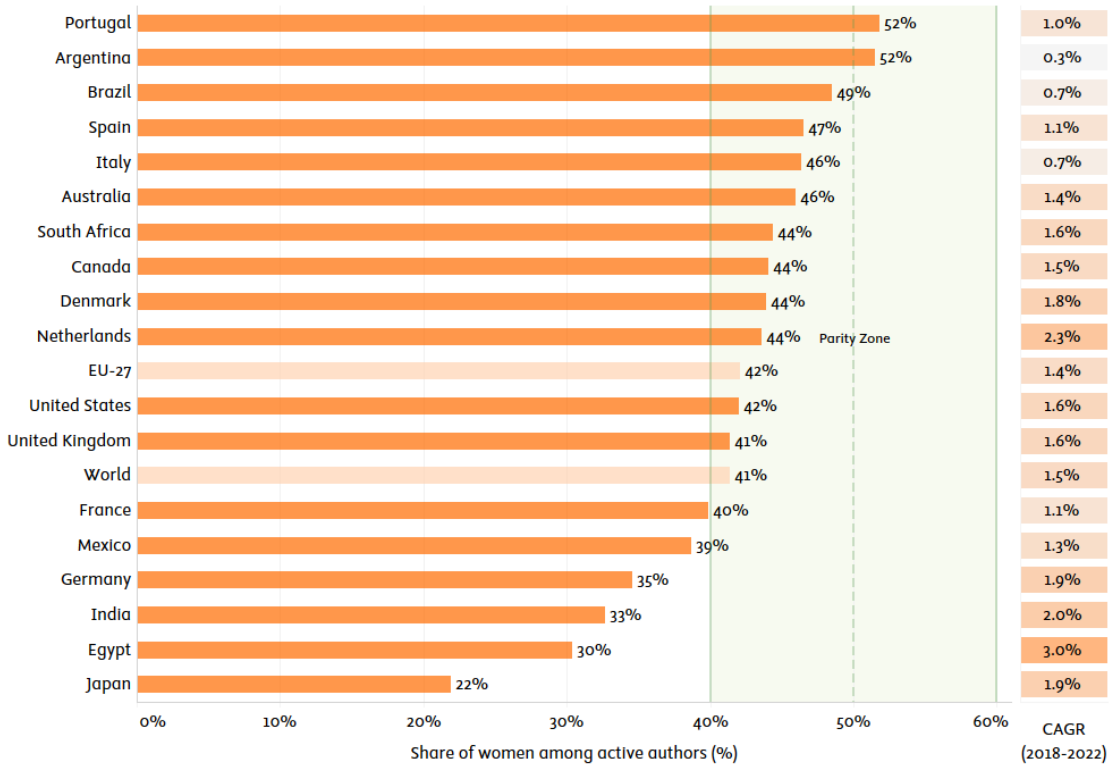

FIGURE 1-4
Proportion of women researchers by country and region (World and EU-27 appear in a lighter shade) in 2018–2022 and Compound Annual Growth Rate of women's participation during the same period.
Source: Scopus and NamSor data

1.2 Grant participation

Across the countries with sufficient grant data available, the average share of women among grant awardees increased from 29% in 2009 to 37% in 2022. The largest increases were for the Netherlands, the United Kingdom, France, Canada, and Portugal.

Why is this important?

Access to grants profoundly influences researchers' ability to conduct research, publish their work and secure tenured positions. Gender bias in the awards process can drastically shape an individual's career trajectory. In extreme cases, it might even drive people away from research.

How is grant participation measured?

We analyzed the share of women and men grant awardees based on Elsevier's funding database. Awards were attributed to the measured period according to their start year. For country analysis, only those with sufficiently robust funding data were included.

Women have made gains in multiple countries in being awarded grant funding, with Portugal being the first among the analyzed nations to reach parity among grant awardees (FIGURE 1-5). For several countries, including India and Japan, the story is different. These countries ranked at the bottom in 2009, and saw minimal or no gains at all, resulting in larger differences compared with other countries by 2022.

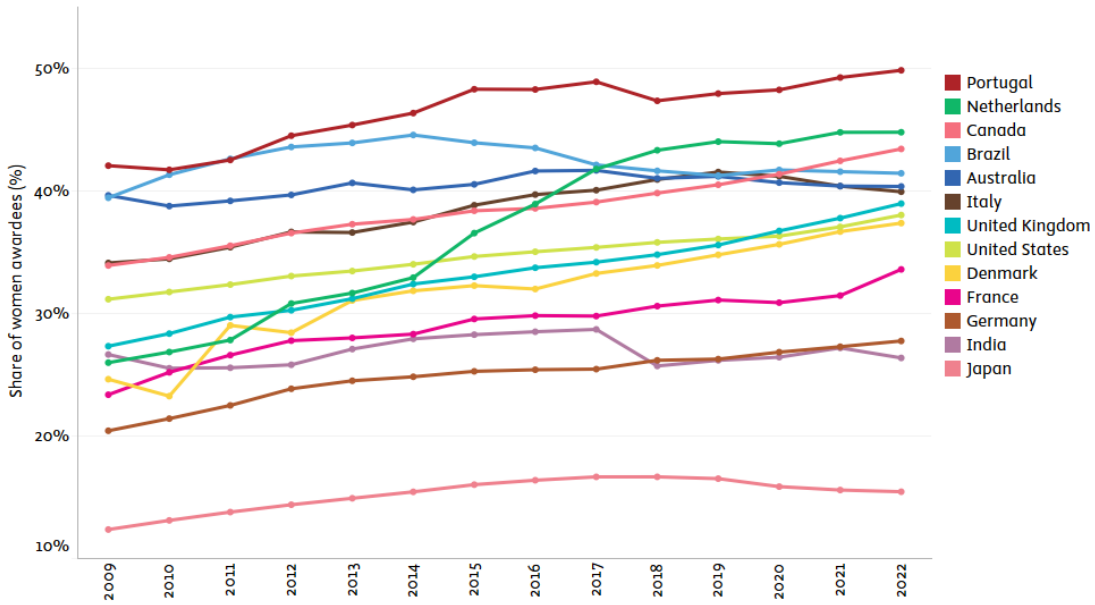

FIGURE 1-5
Trends in shares of women grant awardees, per country (2009–2022).
Source: Scopus and NamSor data

While these increases are encouraging, they do not necessarily indicate that the odds of being funded improved for women. As shown in the previous section, the proportion of women among the population of active researchers also increased in most of these countries. In fact, for most countries, it appears that the gains in grant awards to women were not strong enough to keep pace with the rise in the proportion of women active researchers.

FIGURE 1-6 illustrates the gap between the share of women grant awardees and the share of women active researchers in each country analyzed over time. When the share of women active researchers rises faster than the share of women grant awardees, the result is proportionally fewer women being funded.

This trend is observed in countries like Australia, Brazil, India, Germany, the US, and Japan, with varying degrees of intensity. For example, although the percentage of active women researchers in Australia is increasing, the gap between women grant awardees and active researchers has also increased over the past decade. Portugal is another noteworthy example. While its share of women grant awardees has been the highest among the analyzed countries, there is still a persistent gap between awardees and active researchers.

In contrast, countries like Canada and the UK have seen a narrowing gap between women grant awardees and active researchers. Notably, the Netherlands is the only country standing out for a funding environment favoring women in grant awards.

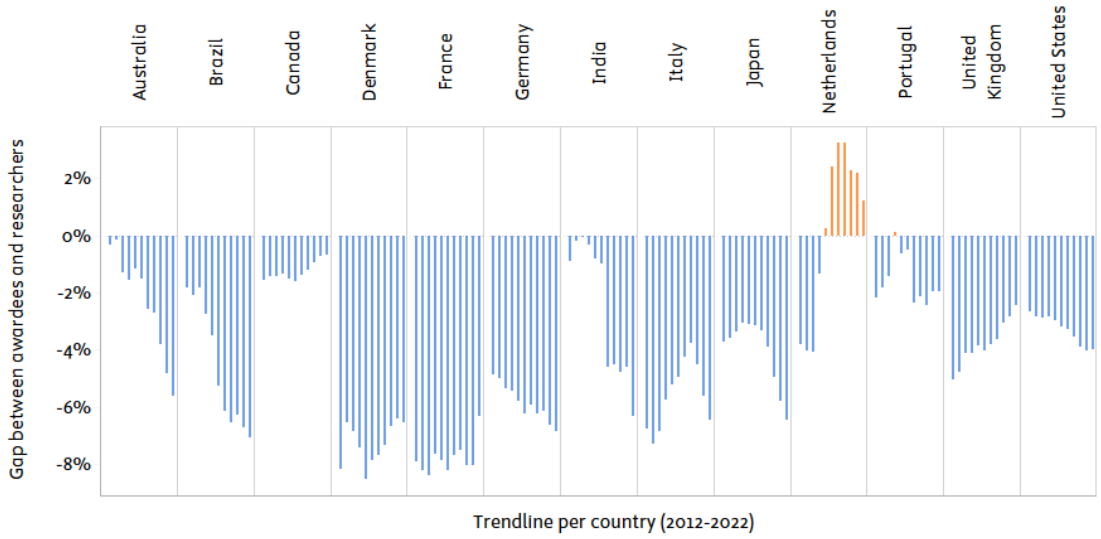

FIGURE 1-6
Gap between women's share of grant awardees and women's share of active researchers, per country. Each bar on the horizontal axis represents a year (2012–2022).
Source: Scopus and NamSor data

While acknowledging that funding data may be incomplete, it is essential to recognize that directly comparing the overall share of awardees with the overall share of active researchers can yield misleading conclusions. Funding often gravitates toward specific disciplines, potentially distorting the results. In this case, Physical and Social Sciences are among the broad subject fields, in which some countries have a notable positive bias towards women.

Chapter 2

Research culture

2.1 Multidisciplinary and interdisciplinary research

Women engage slightly more in multidisciplinary research than men, which involves researchers from diverse disciplinary backgrounds. This trend is observed particularly in Health Sciences, Physical Sciences, and Social Sciences. The only exception is Life Sciences, where men's research is more multidisciplinary.

Why is this important?

Interest in multi- and interdisciplinary research is growing, particularly among research funders, as addressing global societal challenges requires collaboration and knowledge integration across various disciplines. Such integration also tends to produce research with a higher citation impact.

How are multi- and interdisciplinarity measured?

Multidisciplinarity scores quantify collaboration among authors from diverse disciplines, while interdisciplinarity scores quantify the diversity of knowledge integrated in research publications through references. In this section, we explore authors' shares of highly multi- and interdisciplinary publications out of their total output.

Over the past decades, women's research seems to have become slightly more multidisciplinary than men's, while reaching equilibrium in interdisciplinarity. This is measured by averaging women's and men's shares of highly (top 10%) multi- and interdisciplinary publications in Scopus out of their total output (FIGURE 2-1). Full counting is used for this calculation, meaning that each author on a publication receives credit for one publication. For additional information, please see the complete methodology.

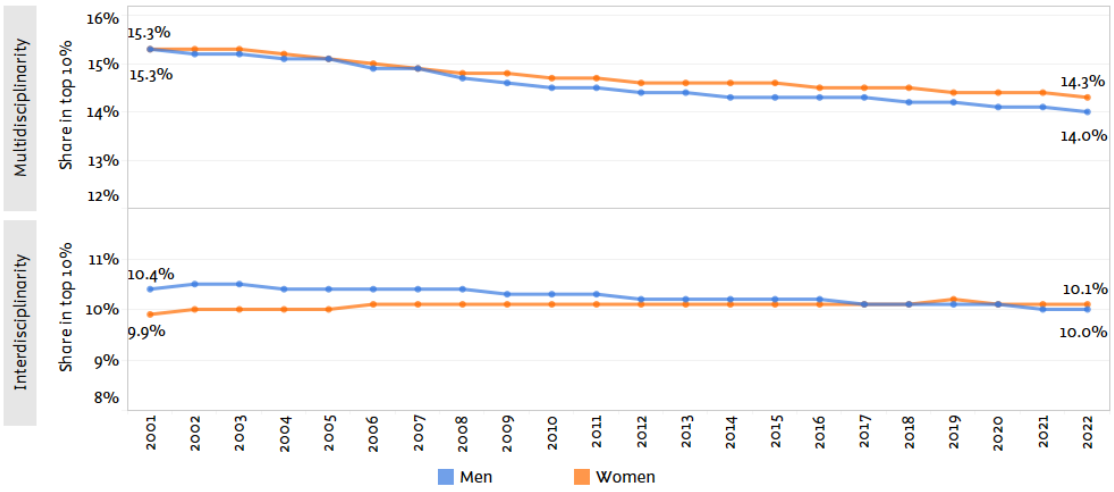

FIGURE 2-1
Trendline of average authors' share of highly multi- and interdisciplinary publications (top 10%) by gender. Note that to emphasize the difference between women and men, the data were adjusted to control for the generally increasing trend in multidisciplinarity and interdisciplinarity over time.
Source: Scopus and NamSor data

Note that while the gap is small, the consistent trendline over time and across vast amounts of data suggests inherent differences in how men and women approach multi- and interdisciplinarity collaborations.

At a more granular level, different patterns of multi- and interdisciplinary collaboration by men and women in distinct disciplines are worth investigating. Note that while multi- and interdisciplinary research inherently transcends individual disciplinary boundaries, examining how these practices manifest within broad disciplines can provide useful insights. Each discipline may have unique barriers and enablers to cross-disciplinary collaboration, influenced by its methodologies, epistemologies, and cultural practices.

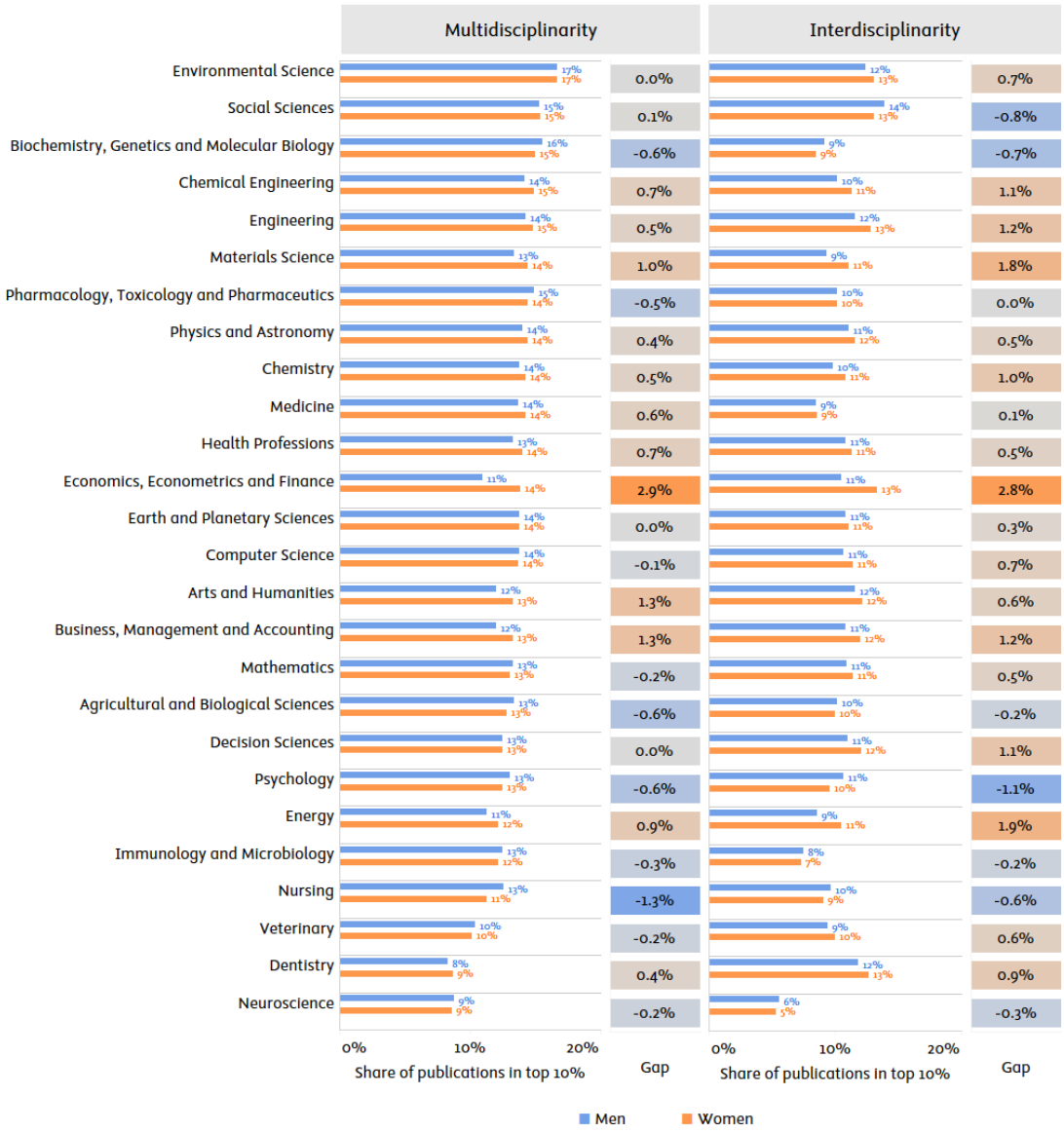

FIGURE 2-2
Average share of highly multi- and interdisciplinary publications (top 10% most multi- and interdisciplinary) for men and women authors by ASJC category, and the gap between the shares (2018–2022). Negative gap (blue shades) signifies higher shares among men, while positive gap (orange shades) signifies higher shares among women.
Source: Scopus and NamSor data

For approximately half of the 26 ASJC disciplines, women exhibit higher levels of multidisciplinarity. Notable differences are observed in Economics, Econometrics and Finance; Arts and Humanities; Business, Management and Accounting; and Energy. Conversely, in disciplines such as Nursing and Psychology, men show slightly higher multidisciplinarity.

Among the disciplines for which women score below men for multi- and interdisciplinarity are the two disciplines where women are most represented: Nursing and Psychology. The lower scores of research involving women in both multidisciplinarity and interdisciplinarity in these two disciplines suggests that there might be underlying dynamics in how women and men approach research in these fields.

One hypothesis is that the differences in research practices relate to potential differences in the professional profiles of men and women who publish. In Nursing, for example, a man who is a physician publishing with women nurses would lead to more multi- and interdisciplinary research in Nursing than women nurses who publish with other women nurses. In this way, the gender balance of the health workforce could drive differences in the interdisciplinarity metric as a measure of research practices.

Differences in multi- and interdisciplinarity can also be observed across geographies. In particular, countries like Portugal, Egypt, UK, Italy, Canada and Japan stand out in terms of higher multidisciplinarity of research conducted by women. As for interdisciplinarity, Egypt has the biggest positive gap in favor of women authors among the analyzed countries, warranting further investigation.

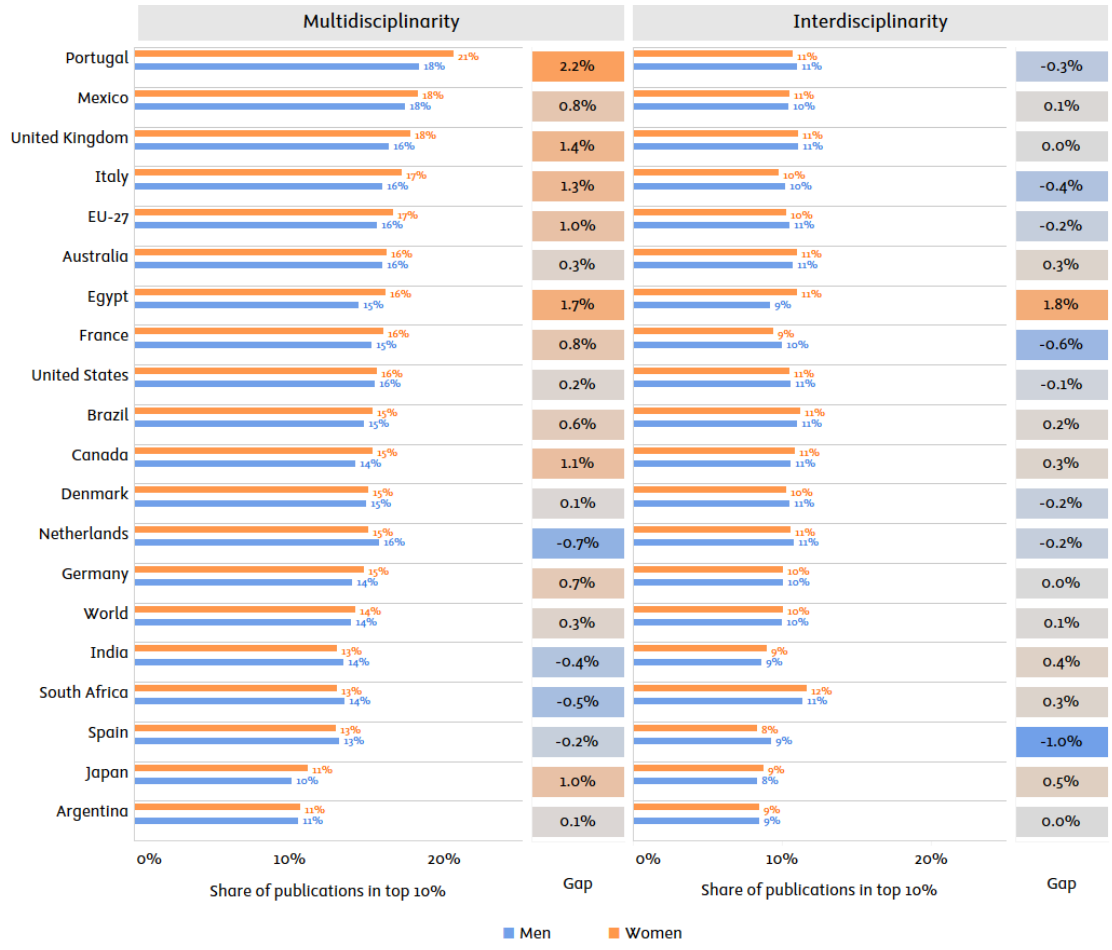

FIGURE 2-3
Average share of highly multi- and interdisciplinary publications (top 10% most multi- and interdisciplinary) for men and women by country, and the gap between the shares (2018–2022).
Source: Scopus and NamSor data

2.2 Open access publication

As of 2022, 45% of all content published by women authors was published Gold open access, compared with 40% for men. This gender gap is consistent across all career cohorts, analyzed countries and most disciplines.

Why is this important?

Researchers and publishers are increasingly evolving their practices to align with open access policies at institutional and governmental levels. In some countries, open access is also becoming a strict requirement of research funders.

How is open access measured?

This analysis uses data from Unpaywall,[8] specifically focusing on Gold open access (including Gold OA articles published in Hybrid journals), wherein publishers offer unrestricted access to articles upon publication, often supported by article publication charges.

As of 2022, 45% of all content involving women authors was Gold open access, compared to 40% authored by men (FIGURE 2-4). Note that to calculate the average share of open access among men and women, we first calculated the share of open access for each author using full counting. Then, the average share among men and women was calculated by taking the arithmetic mean of the shares for authors in each gender group.

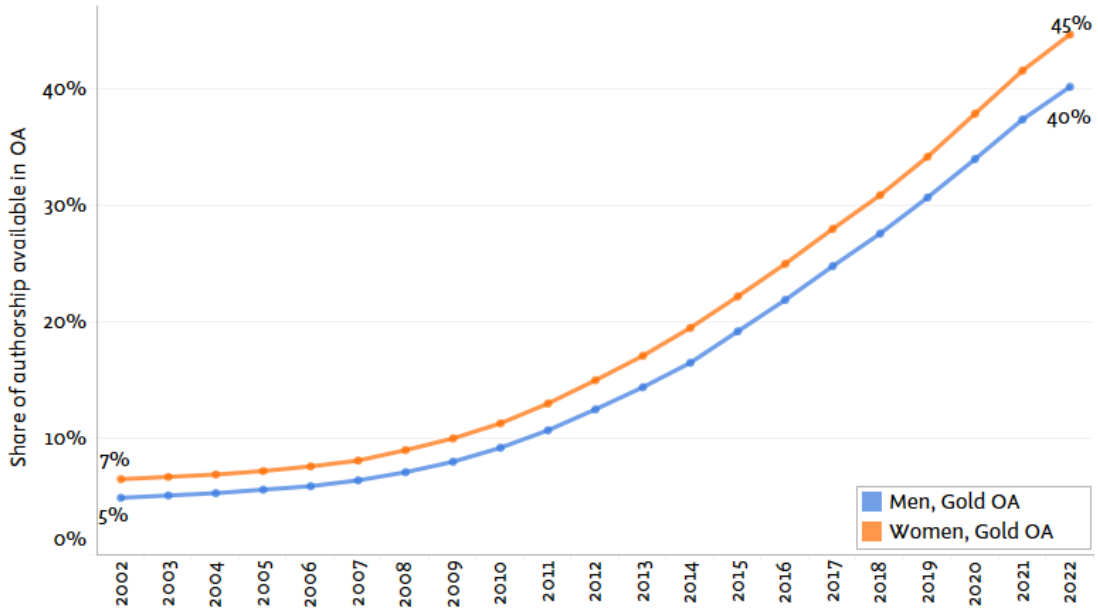

FIGURE 2-4
Average Gold open access publication rate of women and men active researchers (2002-2022).
Source: Scopus, NamSor and Unpaywall data

[8] More information about Unpaywall open access statuses can be consulted online.

Based on this method of calculation, it is important to note that the average share of open access presented here may differ from the overall share of open access publications out of all Scopus publications, as may be presented in other sources. This difference arises because, in this report, the average share is calculated based on the individual shares of included authors (those for whom gender could be inferred). The use of full counting in the calculation, where each author in a publication receives full credit, results in a slightly higher share than if the share were presented as a simple proportion of the total across all Scopus publications.

While women's publication rates in Gold open access are generally higher, significant variations exist across ASJC disciplines, as illustrated in FIGURE 2-5. Disciplines where women have the largest positive gap include Economics, Econometrics and Finance; Earth and Planetary Sciences, and Energy.

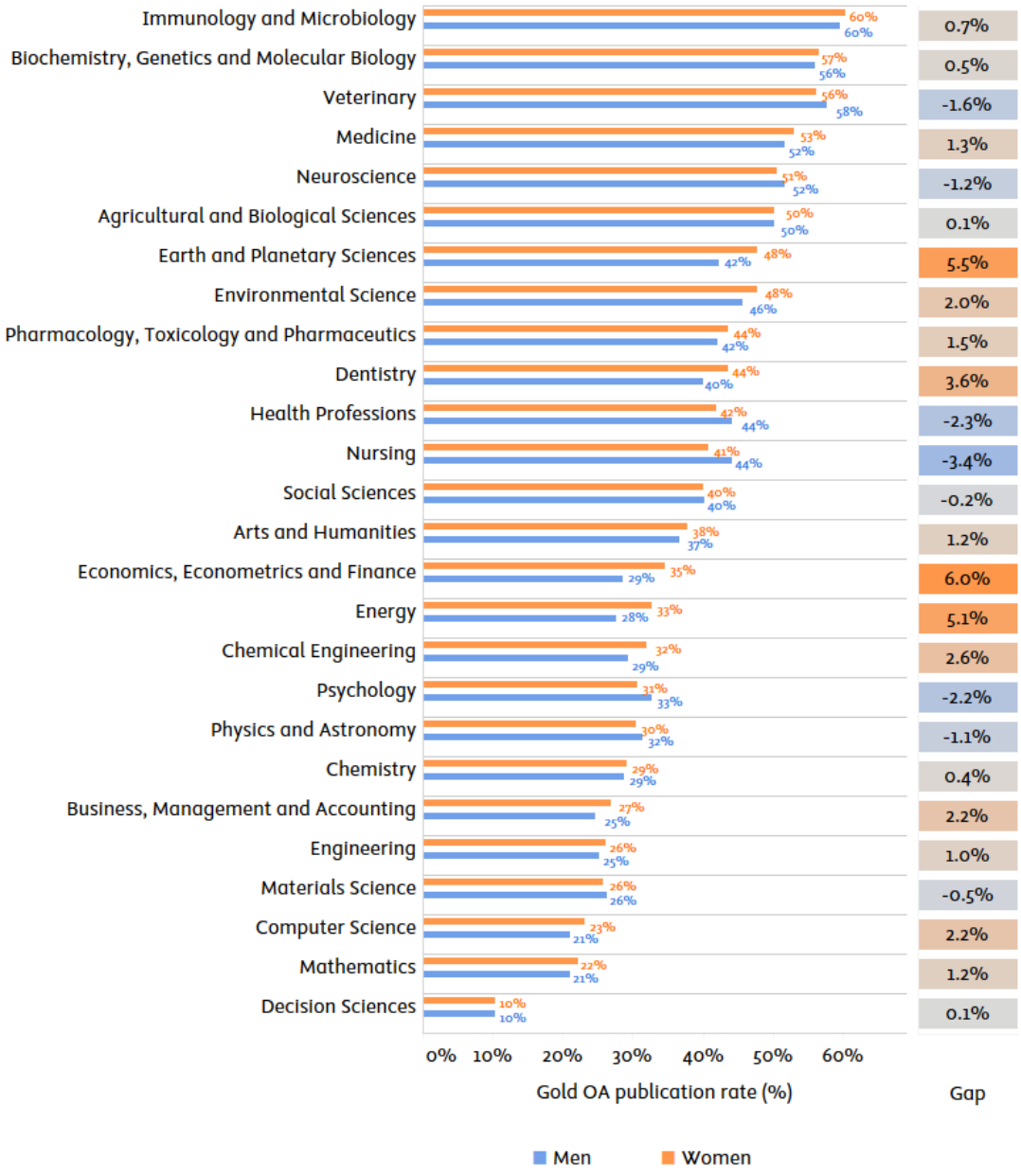

FIGURE 2-5
Average Gold open access publication rate of women and men active researchers, per ASJC discipline (2018–2022).
Source: Source: Scopus, NamSor and Unpaywall data

The higher Gold open access publication rate for research involving women also seems generalized across countries, with women publishing at higher rates than men across all 18 analyzed countries, EU-27, and the world. Three English-speaking countries—the United States, Australia and Canada—trail with regard to open access publication. Europe's leadership in open access policies might explain this disparity, and it will be interesting to monitor progress as further policies are enacted.

To better contextualize the gap, the average open access publication rates in the EU-27 are 54% for women and 46% for men, while in the United States, they are only 37% for women and 35% for men. The publication of the White House memo for open access in 2026 may accelerate rates in the United States in the future.

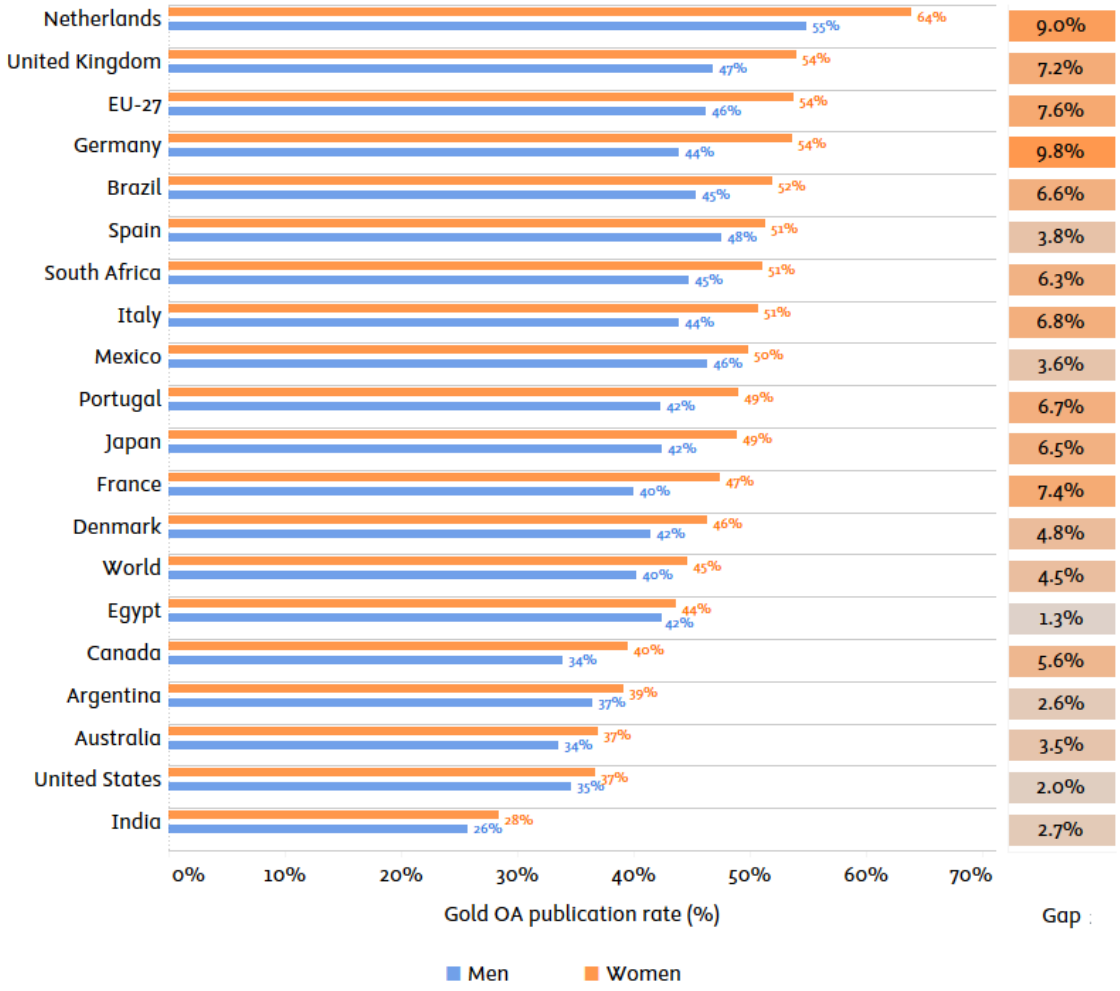

FIGURE 2-6
Average Gold open access publication rate of women and men active researchers, per country (2018–2022).
Source: Scopus, NamSor and Unpaywall data

Chapter 3

Research output

3.1 Research authorship

As of 2022, women are featured as authors on 35% of scientific publications in Scopus. While this share has been steadily growing over time, there is a persistent gap between the share of women active researchers and their authorship, pointing to systemic issues that prevent women from publishing as often as men.

Why is this important?

Publications are how researchers disseminate their findings. Understanding women's contributions as authors to the peer-reviewed scientific literature brings additional insights into their participation within the research ecosystem and opportunities for career progression.

How is authorship measured?

Fractional counting is used to measure authorship. Each author receives a fraction of the publication credit, determined by the total number of authors. For example, in a publication with 5 authors, each author receives 0.2 publications. For more information on fractional counting, please refer to the complete methodology.

Gaining a sense of how men and women contribute to global authorship in research is important to understand where women stand in terms of parity of authorship. FIGURE 3-1 shows that women are listed as authors on approximately 35% of all publications in 2022 where the authors' gender could be inferred. This represents an increase of 50% in women's share of scientific publications compared to 2002.

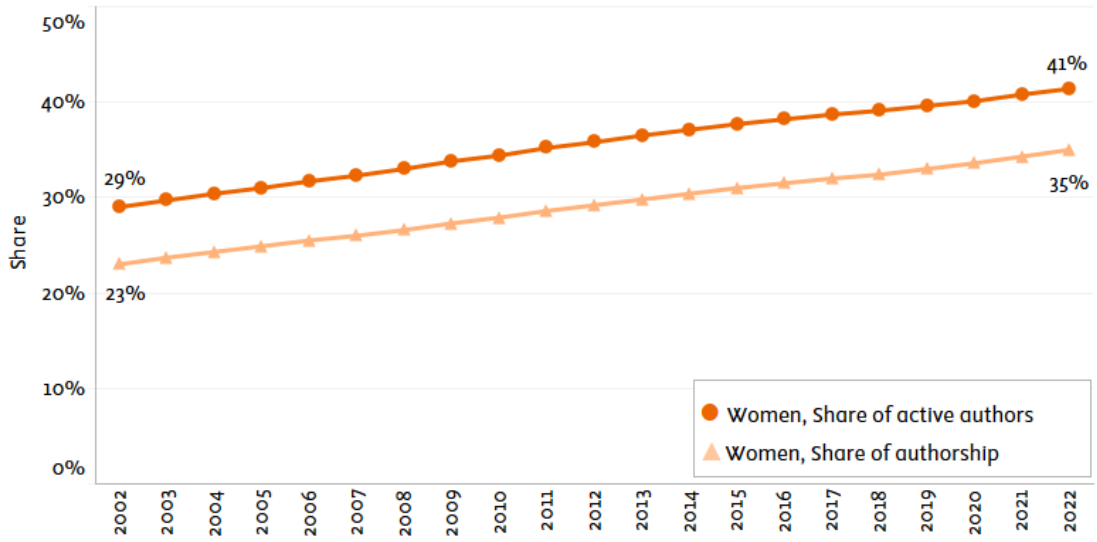

FIGURE 3-1
Trend in the share of authorship by women and share of women active authors.
Source: Scopus and NamSor data

This pattern of continuous increase over time aligns with findings reported earlier for shares of active researchers, highlighting a path toward greater parity. However, it should be noted that the shares of authorship by women are lower than the shares of women active authors. In fact, not only are the shares of authorship always lower, but the gap between authorship and participation as active researchers among women has remained stable over the last two decades, at approximately 6–7 percentage points.

Regardless of the cause, this pattern is pernicious and impacts women researchers across all career cohorts, from early career to advanced career. Such a pattern suggests that the research ecosystem is not fully capitalizing on the growing pool of women researchers to advance knowledge by bringing novel and more diverse perspectives.

Similar to variations in representation observed in terms of active researchers, women's shares of authorship also vary across disciplines, with both metrics correlating strongly. Nursing is by far the category in which women represent the largest share of authorship, with 60% of scientific publications authored by women (FIGURE 3-2). For the same period, women accounted for 68% of all active researchers in this category, again highlighting the publishing gap. Overall, women are authors on more than 40% of publications in 12 of the 26 disciplines, mostly in the same disciplines where women are most represented as active researchers. On the opposite end of the spectrum, women authored less than 30% of scientific publications in eight disciplines, most of these falling under STEM.

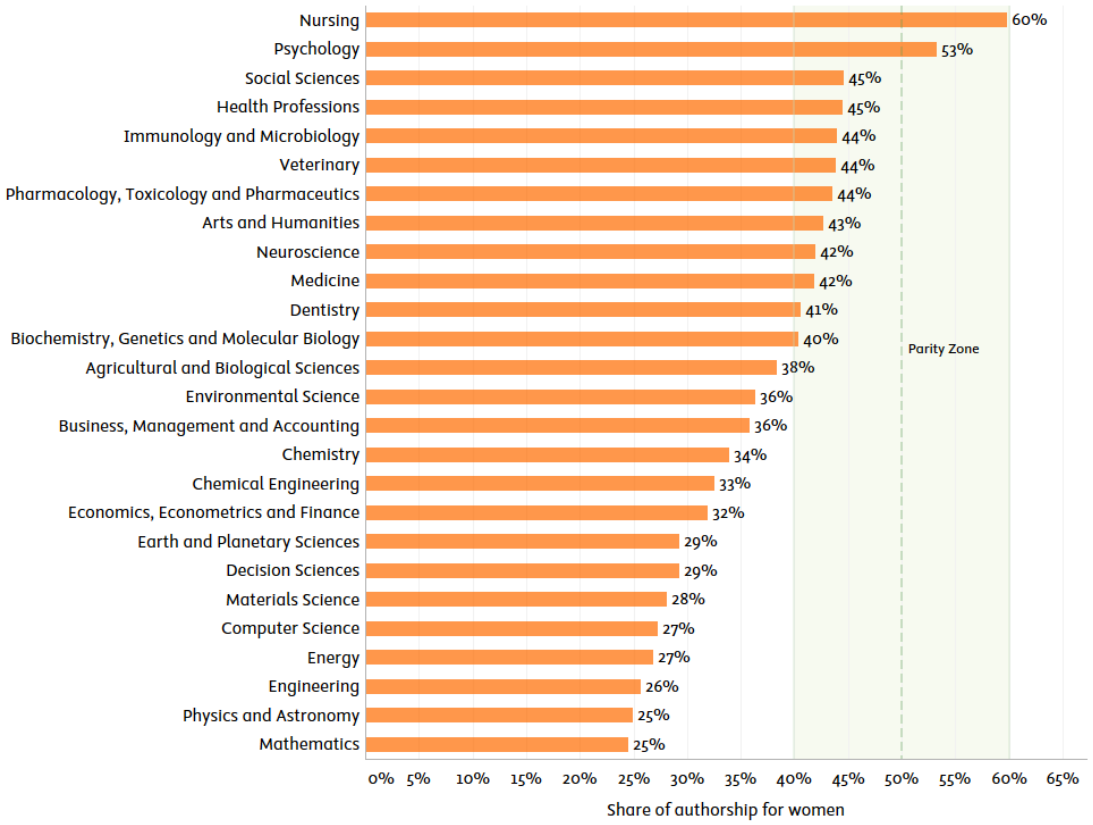

FIGURE 3-2
Shares of authorship for women across disciplines (2018–2022).
Source: Scopus and NamSor data

Authorship shares for women also vary across countries as shown in FIGURE 3-3, but the gap between participation and authorship remains unbridged across all of the analyzed countries. The relative position of countries with the highest and lowest authorship share for women also remains similar to their positions for women's participation, with several Latin and Hispanic countries taking the top positions, while Japan, Egypt, Germany, India and France appear at the bottom.

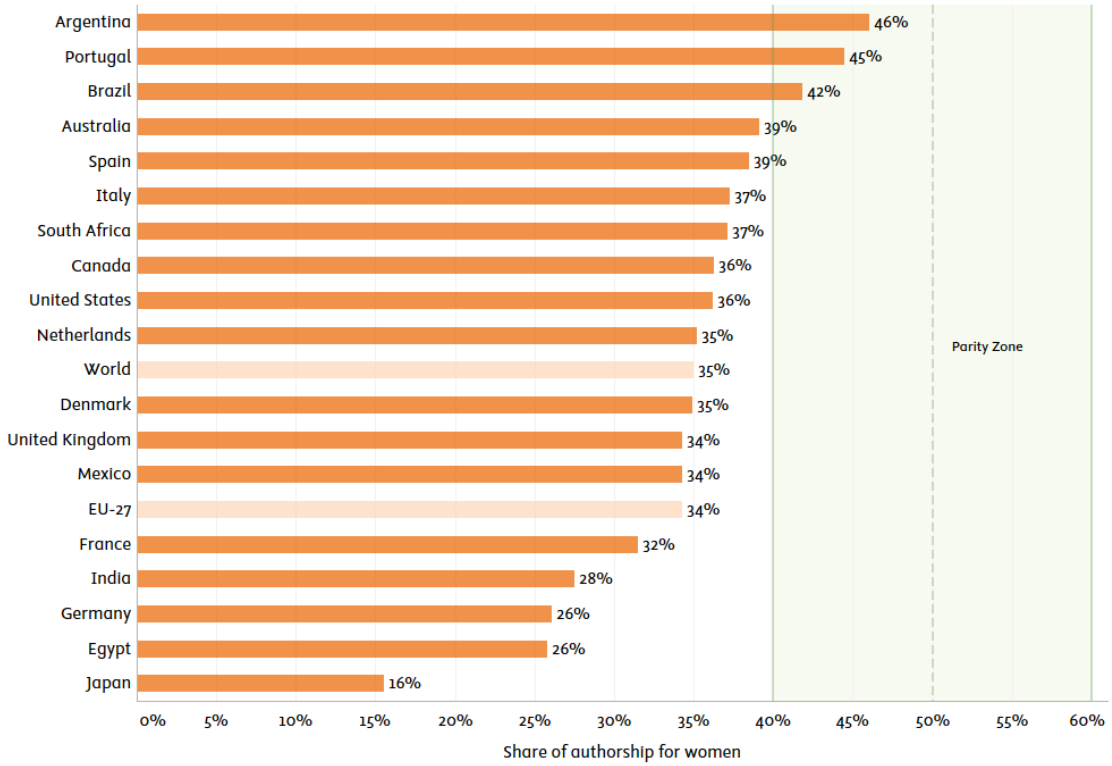

FIGURE 3-3
Shares of authorship for women across countries and regions (2018–2022).
Source: Scopus and NamSor data

3.2 Academic impact

Publications authored by men are, on average, more cited than those authored by women across all broad subject categories, though that gap tends to diminish as careers advance. In fact, research by advanced-career women was cited slightly more than men's in 2018–2022.

Why is this important?

By understanding differences in citations to research conducted by men and women, it is possible to identify potential disparities in patterns of academic recognition, visibility, opportunities and resources.

How is academic impact measured?

To measure citation impact by gender, we group all publications authored by women (or men) and calculate the average field-weighted citation impact (FWCI) score for those publications. An FWCI score of 1.0 indicates the world average.

Historically, men's publications consistently receive more citations on average than women's publications (FIGURE 3-4). This citation gap has remained relatively stable over the years, hovering around 0.05. Although these differences may appear small compared to typical average field-weighted citation impact (FWCI) metrics, the persistent favoring of men's publications suggests underlying systemic issues. From 2018 to 2022, this gap remained across all four broad ASJC categories, although notable variations could be observed across different career cohorts. In particular, publications authored by advanced-career women received slightly more citations than those authored by advanced-career men in 2018–2022 (FIGURE 3-5).

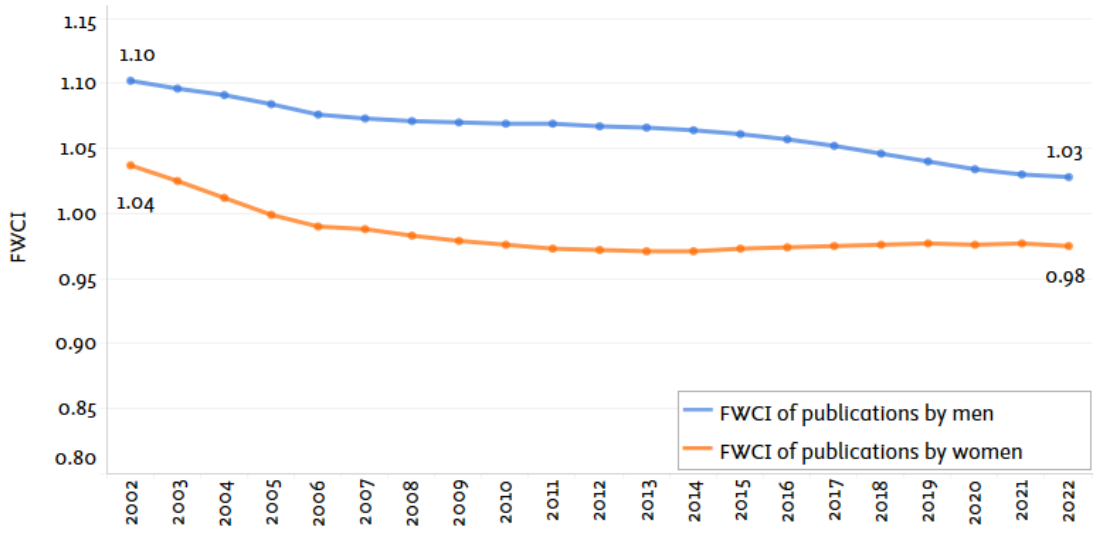

FIGURE 3-4
Citation impact (FWCI) of publications by women and men.
Source: Scopus and NamSor data

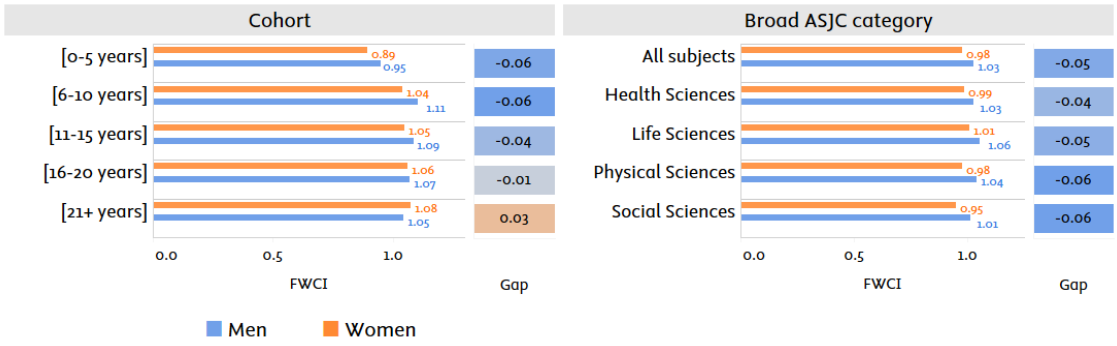

FIGURE 3-5
Citation impact (FWCI) of publications, per cohort (Left) and per broad ASJC discipline (Right). 2018–2022.
Source: Scopus and NamSor data

Because citation practices can be greatly impacted by a researcher's networks and cultural differences, it is normal to expect there could be differences in citation metrics between women and men across geographies. Among the analyzed countries, the UK, South Africa, Mexico, the Netherlands, Japan, Argentina, and Canada exhibit some of the smallest citation gaps between women and men.

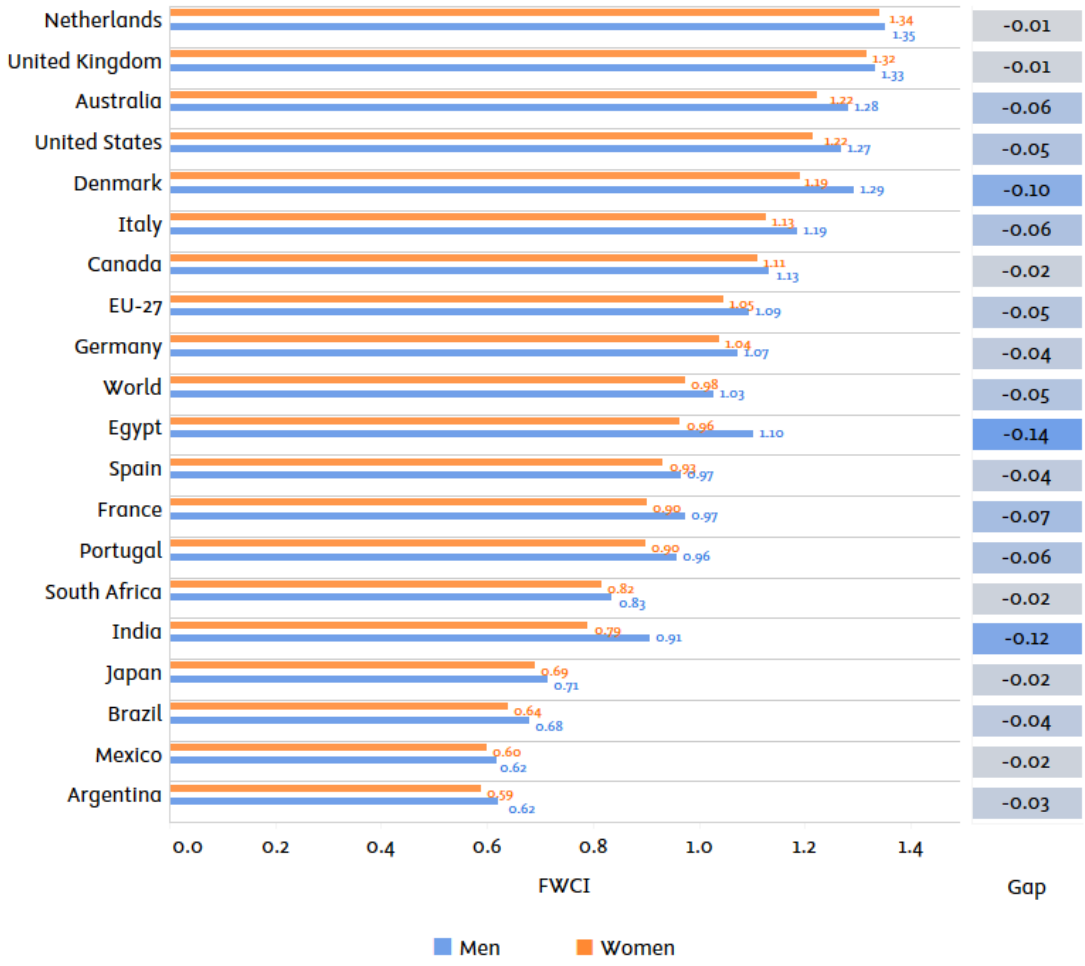

FIGURE 3-6
Citation impact (FWCI) of publications by women and men authors, per country and region (2018–2022).
Source: Scopus and NamSor data

3.3 Research innovation and patent output

Women file vastly fewer patent applications than men. The growing share of women in research has not led to a similar share of women in innovation, the arena in which scientific research is transformed and applied to industry and commerce.

Why is this important?

Patent output represents tangible results of scientific research translated into practical applications. Patents serve as a protection of intellectual property. Patent output is often used as a proxy for contributions to innovation, technological advancement, and potential economic impact.

How is patent output measured?

Data from two major markets (the United States and Europe) and the WIPO authority, through patent applications filed at their respective patent authorities, is used to analyze the participation and contribution of women to patent activity.

On the world stage, women are severely underrepresented in terms of patent application filing, and though women have a slightly higher rate of participation in patent applications in 2022 than they did in the past, they remain substantially in the minority (FIGURE 3-7). As of 2022, women only appear as filers on 26% of all patent applications; in comparison, men are filers on 97% of all patent applications. This underscores the reality that nearly all innovations, as gauged by patent filings, invariably involve at least one man.

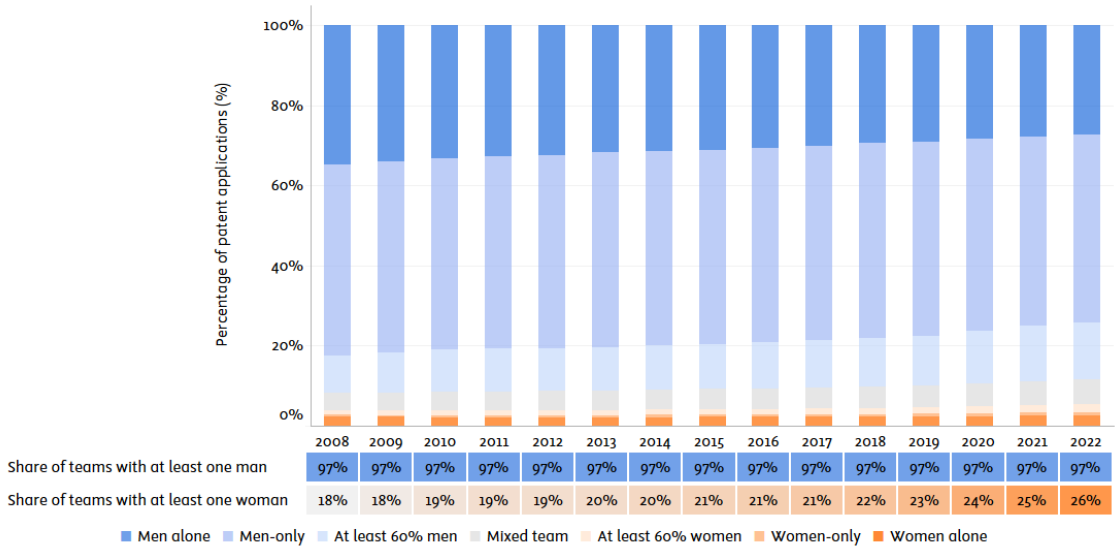

FIGURE 3-7
Trend in team composition on patent applications (2008–2022).
Source: LexisNexis patent data from the USPTO, EPO and WIPO authorities

At the current rate (4.2% CAGR in 2018-2022), it would take nearly 25 years for women to be filers on 50% of all patent applications. Still, with men being so disproportionately represented on all patent applications, this would still not represent full parity, as men would still vastly outnumber women overall.

Across countries, the same pattern is observed with almost no exceptions (FIGURE 3-8). Countries with relatively higher shares of participation by women in patent innovation include Portugal (11% of applications by women-driven teams, women present on 45% of all applications); Spain (9% and 39%, respectively); Mexico (6% and 33%, respectively); Brazil (8% and 31%, respectively); and France (6% and 30%, respectively). Among the countries analyzed, Japan, South Africa, Egypt, Germany and Italy have the lowest shares. The EU-27 stands only on par with the world level, largely because of Germany's low shares.

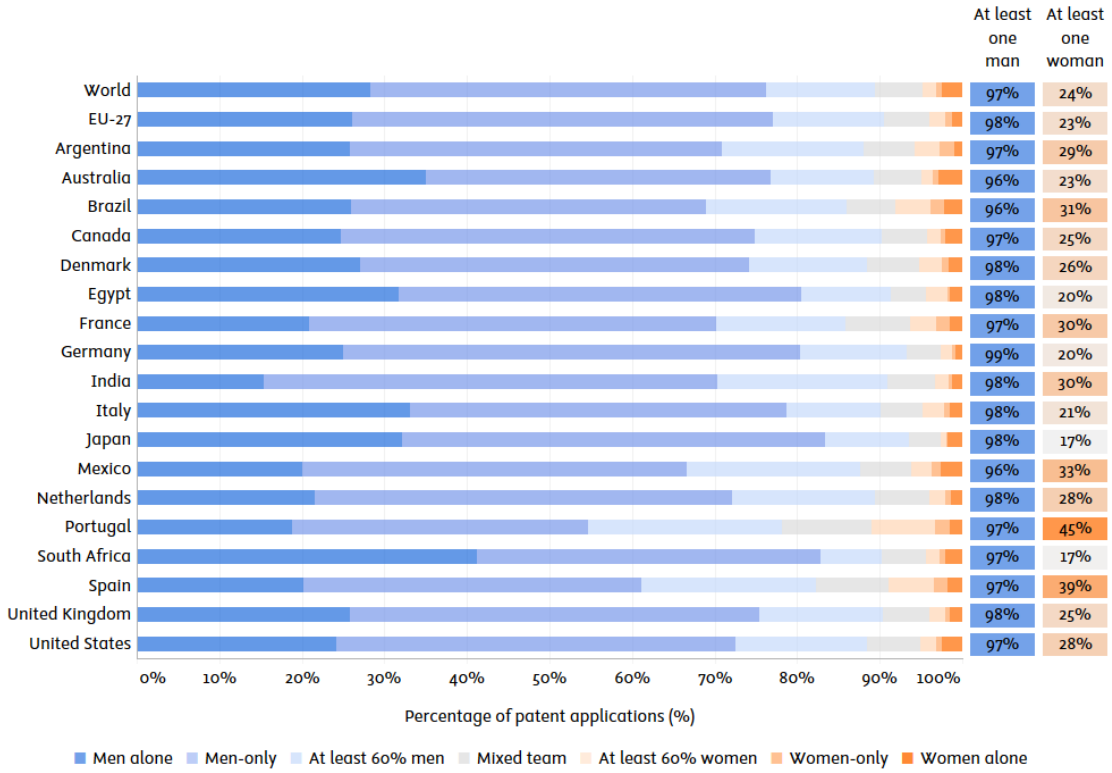

FIGURE 3-8
Team composition on patent applications, per country (2018–2022).
Source: LexisNexis patent data from the USPTO, EPO and WIPO authorities

As with analyses of scientific publications, gender patterns vary widely across sectors. FIGURE 3-9 shows the eight main sections of the International Patent Classification (IPC). For applications with at least one woman, shares range from a low of 11% in section E (Fixed Constructions) to a high of 42% in section C (Chemistry; Metallurgy). Other sectors with shares above the global average are Human Necessities (section A) and Textiles; Paper (section D).

Both section C (Chemistry; Metallurgy) and section A (Human Necessities) have 8% of their total applications from mostly women-driven teams. Interestingly, Human Necessities is also the sector with the greatest share of applications filed by only one woman, with almost double the share of most other categories. This may be related to this IPC category covering inventions in the field of health and well-being, which are the fields with some of the highest research participation and authorship for women. However, at approximately 4%, this is still a relatively low level; patent applications filed by only one man, in comparison, account for 28% of all patent applications in this sector.

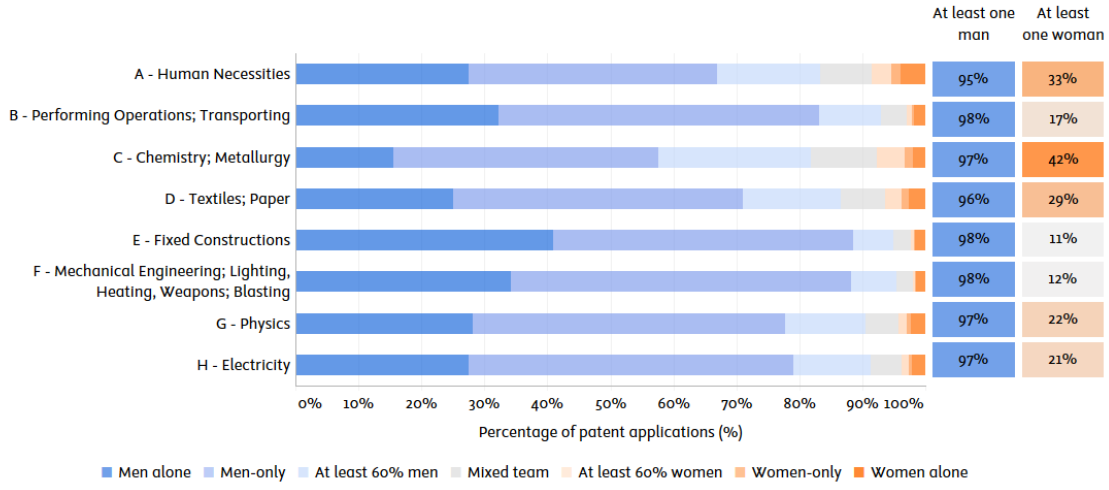

FIGURE 3-9
Team composition on patent applications, per IPC section (2018–2022).
Source: LexisNexis patent data from the USPTO, EPO and WIPO authorities

Chapter 4

Research outcomes and impact

4.1 SDG research

Women comprise the majority of active researchers on some United Nations Sustainable Development Goals (SDGs), including education, gender equality, reduced inequalities and peace and justice.

Why is this important?

The adoption of SDGs marked a shift in global development policy. Research aimed at advancing SDGs is crucial to meeting the needs of the present without compromising the ability of future generations to meet their own needs.

How is SDG research measured?

This section provides an overview of women's participation in research addressing key societal challenges, drawing on Elsevier's mapping of SDGs.[9] Participation in SDGs indicates the extent to which researchers align their work with key societal challenges.

The 17 SDGs were established as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. They are an integral part of the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015. This ambitious agenda aims to address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice.

Women's representation in the SDG research ecosystem has made significant gains over time, reaching notable participation rates across most SDGs in 2018–2022 (FIGURE 4-1). The SDGs that rank the highest in terms of women's share of active researchers are education (SDG 4), gender equality (SDG 5), reduced inequalities (SDG 10) and peace and justice (SDG 16).

Earlier career women researchers show somewhat comparable representation to men across 13 of the SDGs; this is not true for senior women researchers, highlighting how critical it will be to have policies in place to retain earlier-career women in these areas to have greater parity in the future (FIGURE 4-2).

Senior women researchers are severely underrepresented in affordable and clean energy (SDG 7), industry, innovation, and infrastructure (SDG 9), sustainable cities and communities (SDG 11) and climate action (SDG 13), for which their share falls at or below 25%. These are also the four SDGs presenting with the smallest shares for the earliest-career cohorts (ranging between 33% and 42%), indicating that, if nothing more is done to recruit more women to these SDGs, time alone will not be enough to reach parity within 20 years. Overall, 11 SDGs have shares of women active researchers below 30% in the advanced-career cohort.

[9] The Elsevier 2023 SDG queries

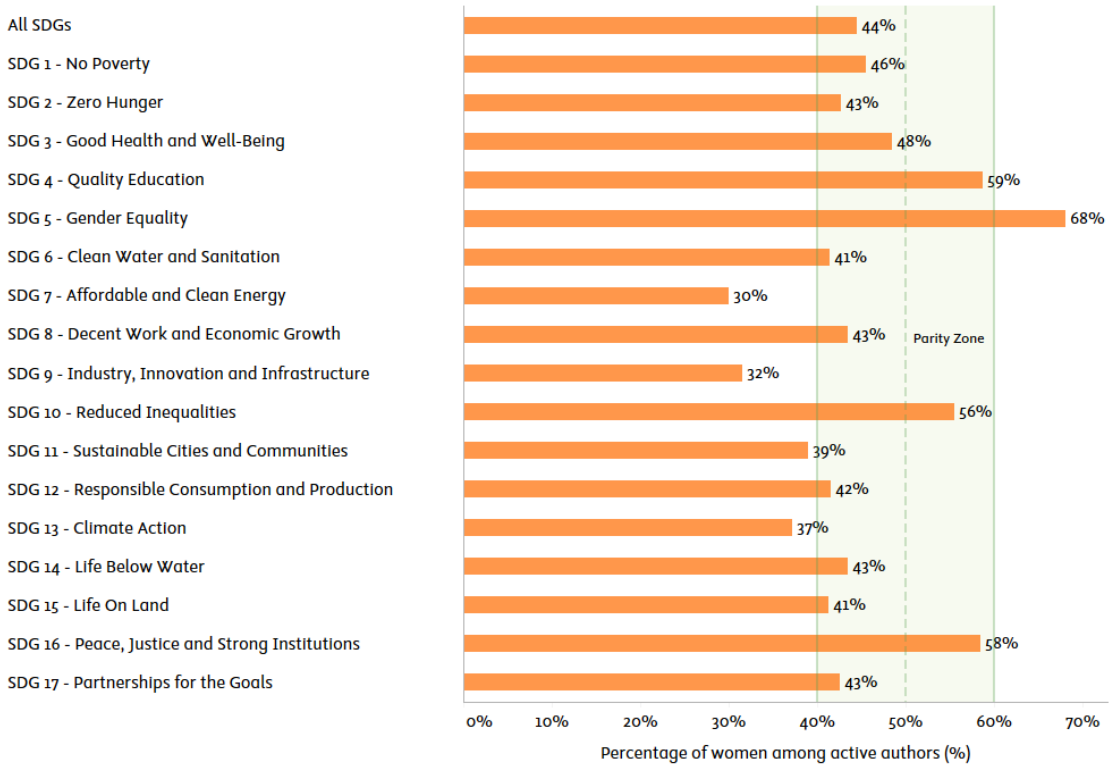

FIGURE 4-1
Share of women active researchers across UN SDGs in 2018–2022.
Source: Scopus and NamSor data

FIGURE 4-2
Share of women active researchers across UN SDGs by cohort in 2018–2022.
Source: Scopus and NamSor data

4.2 Societal impact and alternative metrics

Women's research receives more policy citations, news and blog mentions, while men's research is more often cited in Wikipedia and patents. This trend persists across all career cohorts and broad subject fields.

Why is this important?

While traditional bibliometric indicators are useful for measuring scientific impact, they do not fully capture the breadth of researchers' contributions to advancing knowledge. Alternative metrics can therefore serve as a useful supplement to capture these broader contributions.

How is societal impact measured?

This section uses a different lens to examine impact by analyzing alternative metrics, such as mentions on Wikipedia, news sources and blogs, as well as the citation of research in patent and policy documents.

An overview of alternative metrics across career cohorts reveals clear patterns (FIGURE 4-3). Research authored by women across all career stages is less frequently cited in patent documents. Given the severe underrepresentation of women among patent inventors, as shown in Chapter 3, this might not be surprising, as team composition on patent applications must play a role in how research gets cited in patents. Men, across all career stages, tend to receive more mentions than women on Wikipedia. Given known gender biases in both contributions and content on Wikipedia (women account for only approximately 10% of all Wikipedia authors, and women require more notoriety to have an individual Wikipedia page), these results are not necessarily surprising either, but no less important.

However, patterns for the other alternative metrics—mentions in news sources, blogs and citations in policy documents—present a different picture. Research involving women receive higher scores than research involving men across all of these metrics across all career stages.

The gaps between women and men for alternative metrics could be driven by only a few disciplines. When evaluating citations in patent and policy documents by the four broad ASJC categories, women tend to have a lower share of their publications being cited at least once in patent documents, after yearly normalization, compared to men (FIGURE 3-). On the policy side, women's publications score higher than men's in Health Sciences and Physical Sciences, and similarly to men's in Life Sciences and Social Sciences.

Note that policy and patent citation scores are annually normalized to account for the time it takes for these citations to accrue, as the share of publications cited in policy and patent documents decreases closer to the present time. In turn, alternative metrics (Wikipedia, news, blogs) are calculated using a different approach, which also includes a normalization step to account for varying rates of mentions in these sources across time, disciplines, and types of scientific publications. For a detailed explanation, please see the complete methodology.

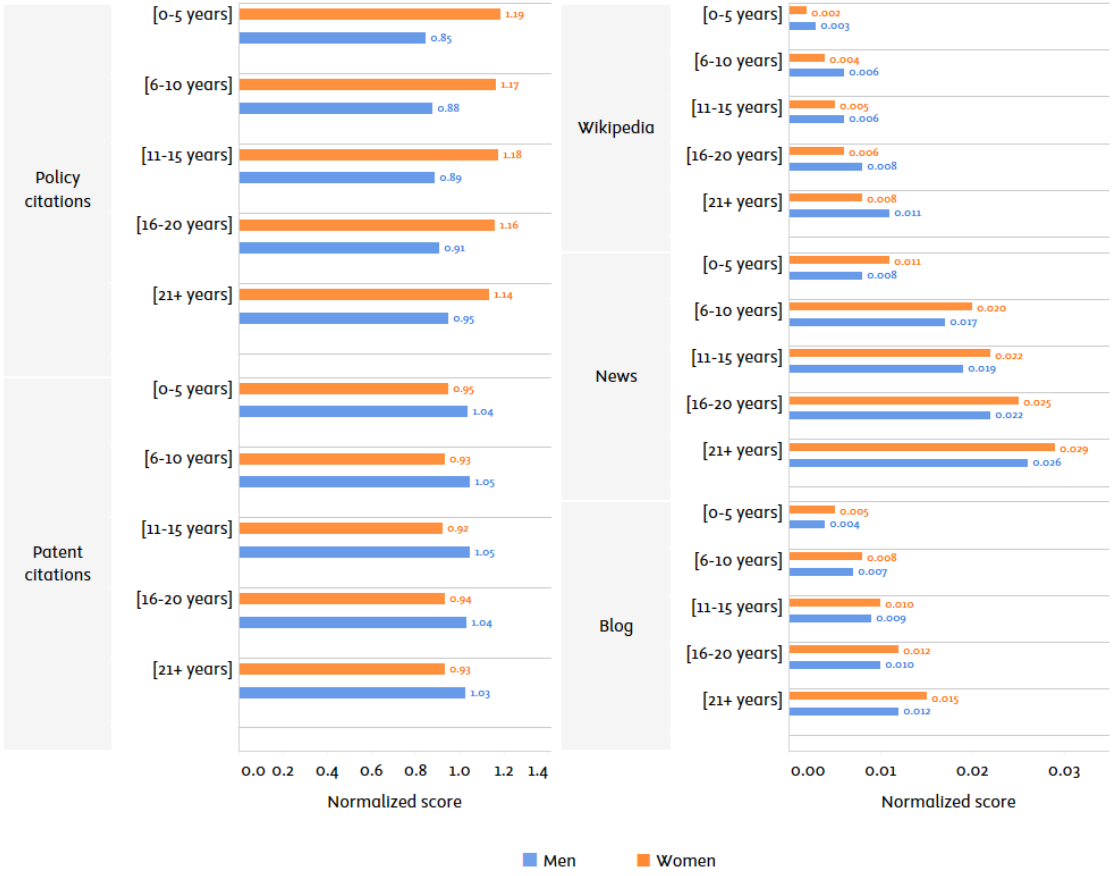

FIGURE 4-3
Comparison of women and men as authors across multiple alternative citation metrics, per career stage (2018–2022).
Source: Scopus, NamSor and Overton data

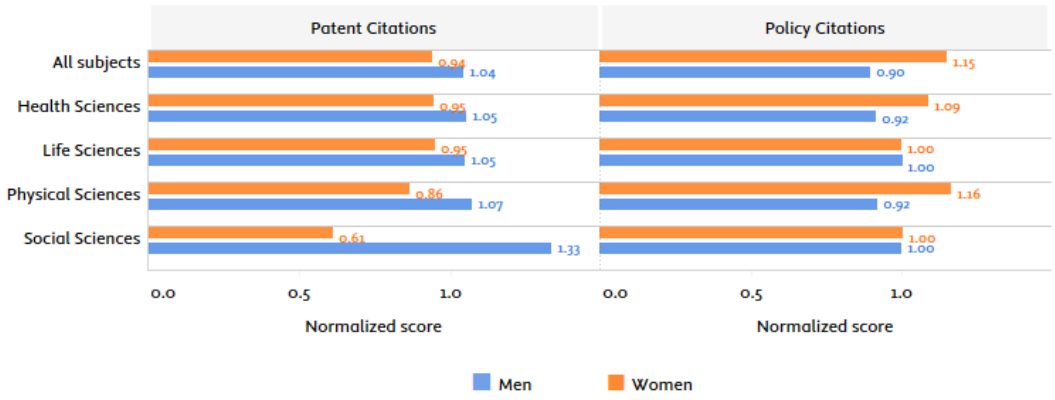

FIGURE 4-4
Comparison of women and men based on patent and policy citation, per broad ASJC category (2018–2022).
Source: Scopus, NamSor and Overton data

Conclusion

Our analysis shows that significant strides have been made towards gender equality in the research ecosystem, but persistent challenges and disparities warrant attention and action, particularly participation in STEM disciplines, access to funding, disparity in authorship rates and citation patterns, and innovation as measured by patent output.

This exploration of gender diversity in research and innovation builds on a decade-long initiative to foster greater equality and opportunities for women in the research workforce. The report, through its in-depth analysis spanning two decades, reveals significant progress towards gender equality in terms of women's growing participation in the research workforce, yet also uncovers enduring challenges and disparities.

The key findings illustrate a nuanced landscape of progress and the persistence of gender gaps across different research domains, geographies and career stages. Notably, while there has been an appreciable increase in the representation of women in the global research community, achieving full parity remains an elusive goal, particularly in STEM fields and in senior research positions. The persistence of the gap between research participation and publication authorship, the underrepresentation of women in patent filings and the regional variations in women's participation in the research workforce highlight systemic hurdles and potential biases that may be inhibiting women's full participation and recognition in research and innovation.

Conversely, the report shines a light on areas where women researchers are making significant impacts. They are contributing to addressing societal issues and research relevant to the Sustainable Development Goals, strengthening an already notable presence in Health Sciences and demonstrating a strong performance in multidisciplinary research, open access publishing, policy and media influence. These findings not only highlight women's achievements but also underscore the value of diversity and inclusivity in driving research that is relevant and impactful to society at large.

In conclusion, this report serves as a critical reflection on the journey towards gender equality in research and innovation. It highlights the significant progress made, acknowledges the challenges that persist and calls for continued effort, innovation and policy interventions to ensure that the research community not only benefits from the full spectrum of talent and perspectives that come with gender diverse research teams, but also fosters an environment where women researchers can thrive and contribute to their fullest potential. We hope this will be a valuable resource for policymakers, funders, institutions and researchers themselves, providing a data-driven foundation for actions aimed at advancing gender equality in the global research landscape.

Key recommendations

Accelerate commitments and actions towards greater gender equality in research

Whilst it is encouraging to see continued progress, progress is still too slow and, at the current pace of change, equality remains unacceptably far away. We need to accelerate action now to build and sustain diverse research teams.

Prioritize retention of early-career women researchers into mid and advanced career stages

Data continue to show a clear decline in the percentage of women authors who reach mid-career stage. Academic leaders and funders should take action to retain early-career women, help them progress in their careers in the research and innovation ecosystem. These actions can include driving an inclusive culture by addressing unconscious bias, actively providing mentoring and coaching, introducing policies that support women through life changes such as parenthood, and aiding access to research funding.

Develop incentive structures to help women play an equal part in the full research and innovation value chain

The persistence of gender disparities in STEM fields and in patent applications highlights the need for strategic interventions to drive change in these innovation related areas. These can include financial incentives, preferential funding opportunities, and targeted training for women on how to translate research to innovation and patents. Implementing policies that remove barriers to participation in the full value chain of research (including patents and IP) and that reward and prioritize gender-diverse teams can enhance women's contribution to innovation and technological and economic advancement.

Apply a broad range of indicators to measure research effectiveness, including societal and policy impact

We advocate for a holistic approach to evaluating research, one that moves beyond traditional bibliometrics such as citations and includes broader indicators of excellence. This approach should include qualitative and quantitative data based on factors such as research culture and societal and policy impact to capture more fully researchers' contributions. As part of this, we need to adopt a longer time frame in evaluation, as the transformation of scientific knowledge into policy and patent citations can be slow, taking up to 10 years.

Continue to collect and report inclusion and diversity data to monitor progress, identify gaps, evaluate policies, and drive accountability

This report affirms the critical role of data in advancing gender equality. Evidence-based insights help to identify and address persistent disparities, such as in participation in STEM disciplines, in access to funding, and in authorship, citation and patent application patterns. Continued collection and reporting of data on key indicators not only helps us to focus on areas to tackle but is also critical for driving accountability.

Acknowledgements

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