

Why it's essential to study sex and gender

Some scholars are reluctant to research sex and gender out of fear that studies will be misused. In a series of specially commissioned articles, *Nature* encourages scientists to engage.

This week, *Nature* is launching a collection of opinion articles on sex and gender in research. Further articles will be published in the coming months. The series will highlight the necessity and challenges of studying a topic that is both hugely under-researched and, increasingly, the focus of arguments worldwide – many of which are neither healthy nor constructive.

Some scientists have been warned off studying sex differences by colleagues. Others, who are already working on sex or gender-related topics, are hesitant to publish their views. Such a climate of fear and reticence serves no one. To find a way forward we need more knowledge, not less.

Nearly 20 researchers from diverse fields, including neuroscience, psychology, immunology and cancer, have contributed to the series, which provides a snapshot of where scholars studying sex and gender are aligned – and where they are not. In time, we hope this collection will help to shape research, and provide a reference point for moderating often-intemperate debates.

In practice, people use sex and gender to mean different things. But researchers studying animals typically use sex to refer to male and female individuals, as defined by various anatomical and other biological features (see page 37). In studies involving humans, participants are generally asked to identify their own sex and/or gender category. Here, gender usually encompasses social and environmental factors, including gender roles, expectations and identity (see page 34).

For as long as scientific inquiry has existed, people have mainly studied men or male animals. Even as recently as 2009, only 26% of studies using animals included both female and male individuals, according to a review of 10 fields in the biological sciences¹. This bias has had serious consequences. Between 1997 and 2000, for instance, eight prescription drugs were removed from the US market, because clinical testing had not revealed women's greater risk of developing health problems after taking the drugs.

The tide, however, is turning. Many journals, including those in the Nature Portfolio, and funders, such as the US National Institutes of Health, have developed guidelines and mandates to encourage scientists to consider sex and, where appropriate, gender in their work.


Many questions are important to ask."

These efforts are reaping benefits². Studies, for example, are showing that a person's sex and/or gender can influence their risk of disease and chances of survival when it comes to many common causes of death – including cardiovascular conditions and cancer.

Despite this, many researchers remain unconvinced that the inclusion of sex and gender information is important in their field. Others, who are already doing so, have told *Nature* that they're afraid of how their work is perceived and of how it could be misunderstood, or misused.

Because researchers who are exploring the effects of sex and gender come from many disciplines, there will be disagreements. An often-raised and valid concern, for example, is that when researchers compare responses between female and male animals, or between men and women, they exclude those whose sex and/or gender doesn't fall into a binary categorization scheme. Another is that variability between individuals of the same sex could be more important than that between sexes.

Sometimes sense does seem to get lost in the debates. That the term sex refers to a lot of interacting factors, which are not fully understood, does not invalidate its usefulness as a concept³. That some people misinterpret and misuse findings concerning differences between sexes, particularly in relation to the human brain, should not mean denying that any differences exist.

Tempering the debate

Many of the questions being raised, however, are important to ask, especially given concerns about how best to investigate biological differences between groups of humans, and the continued – and, in some regions, worsening – marginalization of people whose sex and/or gender identity doesn't fall into narrowly defined norms. Often, such questions and concerns can be addressed through research. For example, studies might find that variability between individuals of the same sex in diet, or body weight, say, are more important predictors of how likely they are to develop anaemia than whether they are male or female.

The problem, then is not the discussions alone: science exists to examine and interrogate disagreements. Rather, the problem is that debates – and work on sex and gender, in general – are being used to polarize opinions about gender identity. As Arthur Arnold, a biologist at the University of California, Los Angeles, and his colleagues describe on page 37, last September, legislation banning gender-affirming medical care for people under 18 years old was introduced in Texas on the basis of claims that everyone belongs to one of two gender groups, and that this reality is settled by science. It isn't. Scientists are reluctant to study sex and gender, not just because of concerns about the complexity and costs of the research, but also because of current tensions.

But it is crucial that scholars do not refrain from considering the effects of sex and gender if such analyses are relevant to their field. Improved knowledge will help to resolve concerns and allow a scholarly consensus to be reached, where possible. Where disagreements persist, our hope is that *Nature's* collection of opinion articles

will equip researchers with the tools needed to help them persuade others that going back to assuming that male individuals represent everyone is no longer an option.

1. Beery, A. K. & Zucker, I. *Neurosci. Biobehav. Rev.* **35**, 565–572 (2011).
2. Tannenbaum, C., Ellis, R. P., Eyssele, F., Zou, J. & Schiebinger, L. *Nature* **575**, 137–146 (2019).
3. Velocci, B. *Cell* **187**, 1343–1346 (2024).

Support those who will lose out in the energy transition

Climate campaigners and politicians focus on the benefits of clean energy, but without more support for communities that are adversely affected, the backlash will only grow.

Thirty million new jobs. According to the International Energy Agency, that's what the clean-energy sector will need by 2030 if the world follows a path towards net-zero greenhouse-gas emissions by 2050, limiting global warming to 1.5 °C above pre-industrial levels. It compares with the 13 million jobs at risk in the fossil-fuel sector under the same scenario. On the basis of the bare numbers, it's a trade-off worth making. But every job lost affects someone, and new jobs won't necessarily be located where the old ones are lost.

As the world transitions away from fossil fuels, communities, states and countries that rely on fossil energy could see their economies falter and their tax bases shrink. Public discontent and backlash from climate policies is increasing in the Americas, Europe and elsewhere. Political leaders are rightly moving to protect the world from the effects of global warming, but more must be done to ensure that those who depend on fossil fuels for their livelihoods are not casualties of the clean-energy transition.

The United States is showing signs of understanding the problem on, or close to, the required scale. The administration of President Joe Biden, working with Congress, has secured around US\$1 trillion in climate spending for the decade to 2032. Billions of these dollars will flow to communities that are dependent on coal, oil and gas for jobs and tax revenues. The spending will cover areas such as environmental remediation and worker reskilling, as well as incentives for businesses to invest in hydrogen energy and carbon capture.

But as such programmes are rolled out, there's an increasing need to assess whether they are achieving the desired objective of bringing about an equitable transition to clean energy. The US-based Resilient Energy Economies (REE) initiative is one project trying to do just that. With a modest sum of almost \$2 million in seed money from the

“**Targeted support for those affected by the clean-energy transition could build support for climate action.**”

Bezos Earth Fund, it is seeking to better understand the economic risks and opportunities for fossil-fuel-dependent communities. Projects already funded include evaluations of recent federal programmes intended to help at-risk communities; efforts to understand the risks and opportunities of decarbonization for members of Indigenous American communities who have worked in the oil and gas industries; and schemes to assess the impact of closure or threatened closure of fossil-fuel power plants on various communities. The REE is also looking to fund new proposals. It is US-focused, but this type of research is in fact needed globally.

There is a precedent for understanding such large-scale economic transitions: researchers have previously studied the loss of industrial jobs in high-income countries as a result of the manufacturing boom in low- and middle-income countries. Work led by David Autor, an economist at the Massachusetts Institute of Technology in Cambridge, has shown how US factory closures associated with a rise in imports from China, particularly after China's entry into the World Trade Organization in 2001, led to economic stagnation in communities across the United States. Between 1999 and 2011, the United States is estimated to have lost up to 2.4 million jobs to this 'China shock' (see go.nature.com/3uhk5cs). By mapping out where these jobs were lost, and comparing this information with district-by-district voting trends, the authors suggest that this shock is associated with the increased political polarization the country is seeing¹.

At the same time, there's evidence that appropriate, targeted support for those affected by the clean-energy transition could build popular support for climate action. A polling study² published earlier this year by political scientist Alexander Gazmararian at Princeton University in New Jersey, for instance, found that most people in coal-dependent communities in the Appalachian region of the United States would be more likely to support climate policies if these were coupled with economic assistance to make the transition less painful. This also holds in Spain, according to a study by Diane Bolet at the University of Essex in Colchester, UK, and her colleagues³.

Environmental economists, pro-climate politicians and campaigners have understandably focused their research and policymaking on the positive aspects of the clean-energy transition, making the case that a green transition creates benefits such as new jobs, cleaner air and more secure food supplies. But there must also be a focus on those who will bear the economic burden of decarbonization.

At last year's COP28 climate conference in Dubai, world leaders pledged to transition energy systems away from fossil fuels. They also committed to doing so in a “just, orderly and equitable manner”. This is not just the right thing to do; it might also be our only hope of building the viable political coalition that is needed to get the work done, for the good of people and communities everywhere.

1. Autor, D., Dorn, D., Hanson, G. & Majlesi, K. *Am. Econ. Rev.* **110**, 3139–3183 (2020).
2. Gazmararian, A. F. *Energy Pol.* **184**, 113880 (2024).
3. Bolet, D., Green, F. & Gonzalez-Eguino, M. *Am. Pol. Sci. Rev.* <https://doi.org/10.1017/S0003055423001235> (2023).