



Researchers who are already cited frequently have been receiving a growing share of citations since at least 2000.

# 'ELITE' RESEARCHERS DOMINATE CITATION SPACE

Just 1% of scientists capture more than one-fifth of all citations globally – and the inequality is growing.

By Sara Reardon

**A**n analysis of more than 26 million scientific studies published by more than 4 million researchers between 2000 and 2015 has found that by 2015, the top 1% most-cited authors accounted for 21% of all citations.

This citation inequality has become more extreme over time, and US-based scientists' share of citations is falling.

Citations are considered a key measure of a paper's importance, and university and funding administrators often take them into account when deciding whether to give a researcher tenure or grants. In their analysis<sup>1</sup>, published in *Proceedings of the National Academy of Sciences*, sociologist Mathias

Nielsen at the University of Copenhagen and bibliometrician Jens Peter Andersen at Aarhus University in Denmark assessed peer-reviewed papers across 118 scientific disciplines in the international Web of Science database.

## Growth in disparity

The researchers designed an algorithm to create a profile of every author with five or more publications. They then found every instance in which each author's papers were cited, adding them all together to create a citation score.

This allowed the team to identify a 'citation elite' – the top 1% most-cited authors – and see how many citations each member of this group received in a given year. Between 2000 and 2015, the proportion of citations that went

to this elite grew from 14% to 21%.

Although most fields showed some increase, the greatest rise in inequality occurred in physics and astronomy. In these fields, the proportion of citations given to the elite jumped from 20% in 2011 to about 22% in 2012, and continued to rise. Nielsen and Andersen are not sure why this jump occurred, but they think it might be a result of the increasing number of large collaborations producing papers with hundreds of authors.

Widely anticipated studies in any field, such as the one announcing the discovery of the Higgs boson, might draw more citations than those that don't generate as much advance publicity, the authors say. And because only limited time is available for experiments using physics and astronomy research infrastructure

such as particle accelerators and telescopes, Nielsen says, the few scientists who have access will be cited frequently.

Cassidy Sugimoto, an informatics researcher at Indiana University Bloomington, thinks that the increasing number of collaborations can explain some of the effect. Collaborations have been steadily rising over the past century at all levels and in all fields of science<sup>2</sup>. She notes that in Nielsen and Andersen's study, when authorship was divided up so that each author got a fraction of the paper, the overall inequality in citation shares remained steady. "I see it as a restructuring and reorganization of science," says Sugimoto. "It highlights that teams are nearly ubiquitous."

Nielsen and Andersen also found a decrease in the share of citations given to papers authored in the United States, and an increase in those given to papers authored in Western Europe and Australasia. The highest concentrations of 'citation elite' researchers were in the Netherlands, the United Kingdom, Switzerland and Belgium.

Vincent Larivière, a bibliometrician at the University of Montreal in Canada, is not surprised. He points out that the proportion of papers from US researchers has been dropping, as well. According to the US National Science Foundation's Science and Engineering Indicators<sup>3</sup>, the United States accounted for 29% of all papers published in 1998 but only 17% in 2018.

Larivière wonders whether excluding scientists with fewer than five publications could have affected the authors' findings. PhD students and postdocs, for instance, might publish only one or two papers before leaving academia for jobs in industry, government or the non-profit sector. If the number of such authors is increasing, this could account for some of the apparent increase in citation

concentration among senior scientists.

Andersen says that he and Nielsen had to limit their analysis to authors with multiple publications for data-quality reasons. Requiring each profile to contain multiple publications in the same field helped their algorithm to distinguish between authors with similar names; including everyone who had a single publication would have made the analysis too difficult. Still, both agree that it would be helpful to understand trends around

**"There's a risk that this elite can define what research is being conducted."**

'transient' authors. "If that group is growing, that makes the concentration at the top even more serious," Nielsen says.

The authors note that their data set probably includes some highly cited authors whose impact has been generated through extreme self-citation, citation 'farms' and ghost authorship.

### Other inequalities

Sugimoto is not too concerned about citation inequality between established authors. She points out that 70% of the authors in Web of Science have fewer than 5 publications, meaning that the most-cited authors among the 4 million included in this study constitute "an elite of the elite", she says. "I think these inequalities are not the inequalities that matter."

Ludo Waltman, a quantitative scientist at Leiden University in the Netherlands, says that the study does not show that citation inequality leads to inequality in funding or career advancement. "In the end, that's what

really matters," he says.

He says that some institutions are moving away from using citation and publication metrics in decisions that affect junior researchers' career arcs. And he adds that some of the citation imbalance might result from elite researchers collaborating frequently with other groups and so ending up with their names on many papers.

But the presence of an elite could be a problem if it influences the direction of research in a field. "It's hard to define some kind of limit for when this is a good thing or bad thing," Andersen says. "But there's a risk that if the concentration becomes too high, this elite can define what research is being conducted and create some kind of monopoly" on which ideas are considered interesting.

Nielsen points to a 2019 paper<sup>4</sup> that found that after a scientific luminary dies, new authors and new ideas begin to enter the field more easily.

Institutions can take steps to decouple funding and tenure decisions from publishing metrics, but it's unclear whether anything can be done about the citation elite, at least until its effects are better understood. Nielsen and Andersen are now looking at whether members of scientific elites preferentially cite each other, and whether transient scientists who work as students or technicians help to build the reputation of the elite authors who employ them.

1. Nielsen, M. W. & Andersen, J. P. *Proc. Natl Acad. Sci. USA* **118**, e2012208118 (2021).

2. Larivière, V., Gingras, Y., Sugimoto, C. R. & Tsou, A. *J. Assoc. Inf. Sci. Technol.* **66**, 1323–1332 (2015).

3. National Science Board. *Publications Output: U.S. Trends and International Comparisons* (National Science Foundation, 2019); available at <https://go.nature.com/2ozy7xd>

4. Azoulay, P., Fons-Rosen, C. & Graff Zivin, J. S. *Am. Econ. Rev.* **109**, 2889–2920 (2019).

# BREAKING THE BINARY AS A TRANS SCIENTIST

Institutions need experts in racial justice and queer liberation to advocate for scientists from under-represented groups. **By Robin Aguilar**

**A**s my intro slide transitioned into view before the audience, I felt distant. My footsteps creaked as I walked to the podium to introduce myself at my department's annual 'get to know you' and networking retreat.

"Hey, some of you might remember me as Liz, but I'm transitioning. My name is Robin! I'm from East Los Angeles and go by 'they/

them' pronouns. Nice to meet you all."

As I handed the microphone back, my words lingered in the air like static. After a roll of applause, I felt my world settle.

Coming out as queer and non-binary at the start of my PhD programme at the University of Washington, Seattle, in 2018 brought me closer to feeling that my identities would be seen and validated in my professional world

as a computational biologist doing research in genomics. I have no regrets, but the decision came with compromises. In social settings and classrooms, despite having spent hours poring through coursework, I have felt spoken over while presenting my ideas. My experiences with untoward biases were dismissed when I brought them up, and it often seemed like my peers ignored me in hallways and at social gatherings.