

State of COVID-19 Research: Summary of Analysis Using Dimensions

Publicly available data from *Dimensions* can be used to explore the global landscape of COVID-19 research and guide the development of new funding initiatives. Dimensions contains over 200 thousand COVID-19 publications, of which 18 thousand are related to vaccines. A unique feature of *Dimensions* is its indexing of over 16 thousand grants distributed by 241 funding organizations, capturing the inputs to research. Using an [online interactive dashboard](#), it is possible to easily answer questions about the landscape, leaders, trends, and inequities of global COVID-19 science.

World leaders of COVID-19 and vaccine research:

- **Publications:** A publication's success can be assessed by its *scientific impact* (number of citations). The top five COVID-19 publications by scientific impact describe the clinical characteristics of COVID-19, whereas the top vaccine papers instead describe the features and safety of mRNA vaccines. Success may also be defined by *social impact*, measured using data from *Altmetrics*, which captures mentions in news, policy, and social media. Social impact highly ranks editorials discussing data integrity in vaccine trials and the virus's origins.
- **Researchers:** Researchers can similarly be ranked by the total scientific and social impact across all their papers. The top researchers by scientific impact are largely Chinese researchers involved in the early investigations of COVID-19, whereas the top vaccine researchers are instead researchers investigating the safety of mRNA vaccines. The top researcher in terms of social impact, however, is Marc Lipsitch—an epidemiologist at Harvard University who gained a large social media following. Interestingly, researchers with high social impact often have more interdisciplinary research than their counterparts with high citation impact.
- **Organizations:** The excellence of an organization can be assessed by their total productivity (number of publications), as well as the proportion of those publications that are in the top 10 percent of all research (measured by citation count). By both metrics, Harvard University is the global leader, followed by the Huazhong University of Science and Technology—the Wuhan-based university that conducted many early studies. While Harvard is also the global leader studying COVID-19 vaccines, Huazhong University is ranked 61st for vaccine research, its position replaced by other universities in the U.S. and the U.K. which spearheaded vaccine development.
- **Funders:** Some of the largest research support in the U.S. comes from the NOAA, which has offered massive grants funding investigation into the impacts of the pandemic on agriculture and climate. Other top funders include the European Commission, the Bill & Melinda Gates Foundation, and subsidiaries of the U.S. National Institute of Health. Funders pursue a diverse range of strategies. Some deploy support through a few large grants, whereas others distribute funding across many smaller grants. Government funders tend to keep funding in their home country and primarily support Universities, whereas Non-profit funders maintain distinct portfolios, offering more support to companies and non-profits, and spreading support across multiple countries.

Landscape of COVID-19 research: By leveraging the neural network technique *word2vec*, it is possible to create a high-resolution map of the COVID-19 concepts indexed in *Dimensions*. The shape of this map reveals a spectrum between research focusing on the biological aspects of COVID-19, on one hand, and its social consequences, on the other. At the middle of the spectrum are topics related to public health, which draw on findings across the spectrum.

Trends in COVID-19 research: Globally, the amount of COVID-19 research has remained roughly stable between Q1 of 2020 and Q4 2021, with vaccine-related research steadily growing. However, differences exist between countries. China produced massive amounts of early research, but lost pace over time, whereas Mexico and Poland instead increased their productivity. The disciplinary focus of COVID-19 research is roughly the same across all countries.

Gender inequities in funding: Using existing bibliometric techniques [1], gender was assigned to grant recipients based on their first name. Across nearly all countries, women receive fewer and smaller grants than men.

Scientific disagreements: The text content of over 2,000 records was sourced from the S2ORC dataset, matched by DOI against Dimensions. Disagreements were identified following a cue-word based approach used in bibliometric research [2]. Within Medicine, high rates of disagreement are found in pediatrics, neuroscience, and clinical sciences.

Recommendations for new funding initiative:

1. **Set clear evaluation criteria:** There are many dimensions of excellence—productivity, scientific impact, and social impact, just to name a few. A new initiative will need clear definitions of success in order to better select researchers, projects, and organizations to support, and to subsequently evaluate their performance.
2. **Support existing projects:** Past studies have demonstrated the difficulty and expense of changing the research agendas of scientists [3]. Indeed, the disciplinary distribution of COVID-19 research is nearly identical across countries regardless of their funding policies. A new initiative should instead support an overall *quantity* of research by providing smaller grants to researchers already engaged in relevant work.
3. **Support diversity of investigators:** Researchers' demographics have been shown to be vital to which topics are investigated [4,5], yet as this report illustrates, women receive fewer and smaller grants than men. The new initiative to take steps to support women and marginalized groups to promote equitable and effective science.
4. **Support consensus research:** Ongoing disagreements and uncertainty slow the application of research. New initiatives should prioritize support towards controversial topics to promote actionable scientific consensus.

Caveats: Dimensions is one of the most comprehensive bibliographic databases [6], but lacks coverage of certain fields, countries, and languages. Impact indicators are imperfect measures of performance, and should be considered as one part of holistic evaluation. Name-based gender assignment is imprecise and should be interpreted cautiously.

Next steps: Dimensions makes it possible to expand this analysis to patents, clinical trials, and datasets. Statistical and machine learning techniques can also be used to identify features contributing to success in COVID-19 science. Cost effectiveness of COVID-19 funding, in terms of scientific outputs, may also be useful for assessing new initiatives.