The Institutionalization of Disparities in Science

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IS ACCESS TO SCIENCE EQUITABLE?

IS PRODUCTION OF SCIENCE EQUITABLE?

IS SCIENTIFIC EVALUATION EQUITABLE?
Disclaimer on classifications

“Counting and measuring do not always have to be tools of oppression. We can also use them to hold power accountable, to reclaim overlooked histories, and to build collectivity and solidarity.” (D’Ignazio & Klein, 2020)

“The racialization of data is an artifact of both the struggles to preserve and to destroy racial stratification.” (Best & Zuberi, 2002)
GATEKEEPERS TO SCIENCE: DOCTORAL PROGRAMS
Who are the doctoral graduates?
Career trajectories
To employment type in 2013
Estimated odds ratio of publishing
At least one article 5 years before or 6 years after graduation
Receipt of research assistantships
% (2010-2018); odds ratio (1995-2006) (SDR)
PRODUCTION OF SCIENCE: CONTRIBUTORSHIP
New forms of attribution

Authorship

Nest Etiquette—Where Ants Go When Nature Calls
Tomer J. Czaczkes, Jürgen Heinze, Joachim Ruther
Published: February 18, 2015 • DOI: 10.1371/journal.pone.0118376

Author Contributions
Conceived and designed the experiments: TJC JH JR. Performed the experiments: TJC. Analyzed the data: TJC. Contributed reagents/materials/analysis tools: TJC JH JR. Wrote the paper: TJC JH JR.

Acknowledgments
Thanks to Anna-Theresa Lorenz for caring for the ants, Jan Oettler and Sylvia Cremer for helpful discussions, to Michaela Fink for performing the blind localisation of the ant toilets in the nests, to Christoph Leidig for composing the title of the manuscript, and to Martha Weiss and the anonymous reviewers for improving the manuscript.
## Description of data

**PLOS journal articles**

<table>
<thead>
<tr>
<th>Contribution</th>
<th>Articles</th>
<th>Author-article combinations</th>
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<td></td>
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<tr>
<td>Conceived and designed the experiments</td>
<td>85,406</td>
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<tr>
<td>N distinct papers</td>
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<td>100.0%</td>
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Which contributions are isolated?

*Contribution by number of contributions*

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<tr>
<td>Performed the experiments</td>
<td></td>
</tr>
<tr>
<td>Wrote the paper</td>
<td></td>
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</table>
Are labor roles gendered?

Contributions of PLOS ONE papers, based on CRediT

<table>
<thead>
<tr>
<th>Role</th>
<th>Percentage of Authors</th>
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<tbody>
<tr>
<td>Supervision</td>
<td>40%</td>
</tr>
<tr>
<td>Funding acquisition</td>
<td>30%</td>
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<tr>
<td>Resources</td>
<td>30%</td>
</tr>
<tr>
<td>Conceptualization</td>
<td>50%</td>
</tr>
<tr>
<td>Software</td>
<td>30%</td>
</tr>
<tr>
<td>Writing - Review &amp; Editing</td>
<td>70%</td>
</tr>
<tr>
<td>Project administration</td>
<td>40%</td>
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<tr>
<td>Validation</td>
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<tr>
<td>Methodology</td>
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<td>Visualization</td>
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<tr>
<td>Formal analysis</td>
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</tr>
<tr>
<td>Writing - Original Draft</td>
<td>40%</td>
</tr>
<tr>
<td>Data curation</td>
<td>40%</td>
</tr>
<tr>
<td>Investigation</td>
<td>50%</td>
</tr>
</tbody>
</table>

Female | Male
--- | ---
0% | 70%
10% | 80%
20% | 60%
30% | 50%
40% | 40%
50% | 30%
60% | 20%
70% | 10%
80% | 0%
Predicting contributions
Robinson-Garcia et al. (2020)
Archetypal analysis
Robinson-Garcia et al. (2020)

- **Profile 1** related with leadership and multitasking – Leader
- **Profile 2** related with specialized knowledge – Specialized
- **Profile 3** related with specific contributions related with tools – Supporting
Gender differences in contribution
Robinson-Garcia et al. (2020)
Archetype trajectories
Robinson-Garcia et al. (2020)
GATEKEEPERS OF PRODUCTION: THE CASE OF ELIFE
Selectivity of eLife
Data from 2012-2017

Initial Submission
- Female
- Male

Full Submission
- Female
- Male

First Revision
- Female
- Male

Second Revision
- Female
- Male

Gender of Author

Accepted
Revision needed
Decision pending
Rejected
Accepted
Revision needed
Decision pending
Rejected
Accepted
Revision needed
Decision pending
Rejected
Outcomes by gender

Data from 2012-2017
Outcomes by author gender

Full submissions

![Bar charts showing outcomes by author gender for full submissions.](chart)

- **Corresponding**: Female vs. Male
  - Female: 0.50 ± 0.05
  - Male: 0.55 ± 0.05
  - *Significance

- **First**: Female vs. Male
  - Female: 0.52 ± 0.05
  - Male: 0.50 ± 0.05
  - ns

- **Last**: Female vs. Male
  - Female: 0.51 ± 0.05
  - Male: 0.55 ± 0.05
  - *Significance
Outcomes by review team composition

Full submissions

The diagram shows the outcomes of submissions by gender of the last author, categorized by review team composition:

- **All-male reviewers**
  - Female: 520 submissions
  - Male: 1952 submissions

- **All-female reviewers**
  - Female: 21 submissions
  - Male: 56 submissions

- **Mixed-gender reviewers**
  - Female: 735 submissions
  - Male: 2211 submissions

The significance levels are indicated by:
- * (significant)
- ns (not significant)
What are your odds of acceptance?
Encouraged and submitted manuscripts
Role of reviewing editor

Composition of peer review teams

![Bar charts showing the composition of invited peer reviewer teams for female and male reviewing editors.]

- **Female Reviewing Editor**
  - All male: 49.5%
  - Mixed: 34.9%
  - Uncertain: 11.6%
  - All female: 4%

- **Male Reviewing Editor**
  - All male: 56.2%
  - Mixed: 28.1%
  - Uncertain: 12.1%
  - All female: 3.6%

Composition of invited peer reviewer teams
GLOBAL LEVEL:
GENDER DISPARITIES
Gender differences in production?
Female/male productivity by country (2008-2017)
Gender segregation by discipline?

Female/male productivity by discipline
Gender differences in collaboration?  
National vs. international collaboration by gender

<table>
<thead>
<tr>
<th>National Collaboration</th>
<th>International Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey</td>
<td>80%</td>
</tr>
<tr>
<td>India</td>
<td>70%</td>
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<tr>
<td>Iran</td>
<td>60%</td>
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<tr>
<td>Taiwan</td>
<td>50%</td>
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<tr>
<td>Japan</td>
<td>40%</td>
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<tr>
<td>South Korea</td>
<td>30%</td>
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<tr>
<td>Brazil</td>
<td>20%</td>
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<tr>
<td>China</td>
<td>10%</td>
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<tr>
<td>United States</td>
<td>0%</td>
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<tr>
<td>Poland</td>
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<tr>
<td>Romania</td>
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<td>Russia</td>
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<td>Malaysia</td>
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<td>Greece</td>
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<tr>
<td>Mexico</td>
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<td>Spain</td>
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<td>Israel</td>
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<td>Australia</td>
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<td>Italy</td>
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<tr>
<td>Argentina</td>
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<td>Canada</td>
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<td>Czech Republic</td>
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<td>Germany</td>
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<td>Netherlands</td>
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<td>New Zealand</td>
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<td>Hungary</td>
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<td>United Kingdom</td>
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<td>France</td>
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<td>Singapore</td>
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<td>Iceland</td>
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<td>Norway</td>
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<td>Sweden</td>
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<tr>
<td>Denmark</td>
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<tr>
<td>South Africa</td>
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<tr>
<td>Thailand</td>
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<tr>
<td>Belgium</td>
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<tr>
<td>Austria</td>
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<tr>
<td>Switzerland</td>
<td>0%</td>
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<tr>
<td>Philippines</td>
<td>0%</td>
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Proportion of Authors

Number of Authors

[Bar chart showing gender differences in national and international collaboration across various countries]
### Intersectional homophily

Collaboration propensity by race/gender

<table>
<thead>
<tr>
<th>First author</th>
<th>Last author</th>
<th>All co-authors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White Men</td>
<td>Hispanic Men</td>
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<tr>
<td>Asian Men</td>
<td>-7.5%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Asian Women</td>
<td>-12.3%</td>
<td>-10.0%</td>
</tr>
<tr>
<td>White Women</td>
<td>-8.4%</td>
<td>-14.3%</td>
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<tr>
<td>Hispanic Women</td>
<td>-10.3%</td>
<td>26.9%</td>
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<tr>
<td>Black Women</td>
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<td>-14.6%</td>
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<table>
<thead>
<tr>
<th>Last author</th>
<th>White Men</th>
<th>Hispanic Men</th>
<th>Black Men</th>
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<td>Asian Women</td>
<td>-20.4%</td>
<td>19.0%</td>
<td>-20.7%</td>
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<td>White Women</td>
<td>-13.3%</td>
<td>-15.6%</td>
<td>-10.4%</td>
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<tr>
<td>Hispanic Women</td>
<td>-15.8%</td>
<td>-22.2%</td>
<td>-15.6%</td>
</tr>
<tr>
<td>Black Women</td>
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<td>3.9%</td>
<td>-5.8%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>All co-authors</th>
<th>White Men</th>
<th>Hispanic Men</th>
<th>Black Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian Men</td>
<td>-28.4%</td>
<td>-43.4%</td>
<td>-39.9%</td>
</tr>
<tr>
<td>Asian Women</td>
<td>2.4%</td>
<td>421.4%</td>
<td>1.2%</td>
</tr>
<tr>
<td>White Women</td>
<td>-26.3%</td>
<td>-43.8%</td>
<td>-39.7%</td>
</tr>
<tr>
<td>Hispanic Women</td>
<td>-15.5%</td>
<td>-40.1%</td>
<td>-21.7%</td>
</tr>
<tr>
<td>Black Women</td>
<td>24.7%</td>
<td>152.8%</td>
<td>-38.2%</td>
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SYSTEMATIC SEGREGATION AND BARRIERS TO ENTRY
UTILIZATION OF SCIENCE + SCIENTIFIC REWARDS
Gender differences in citation impact

Citation impact by type of collaboration and country
## Disparities by perceived race

*Citation impact (United States, 1976-2018)*

<table>
<thead>
<tr>
<th>Likelihood that surname is associate with race (rounded)</th>
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<th>Black</th>
<th>Hispanic</th>
<th>White</th>
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<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
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<td>1.3</td>
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<td>1.4</td>
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<td>1.2</td>
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<td>70%</td>
<td>1.3</td>
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<td>80%</td>
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<td>90%</td>
<td>1.3</td>
<td>1.4</td>
<td>0.9</td>
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<tr>
<td>100%</td>
<td>1.4</td>
<td>1.5</td>
<td>1.0</td>
<td>1.0</td>
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Citations v. Impact Factor

Disparity in citations and impact factor by gender
The impact factor gap

Disparity in impact factor by gender

Field-Normalized Impact Factor Class

First author

Last author

ARC

Field-Normalized Impact Factor Class

M

F
UTILIZATION OF SCIENCE FOLLOWS ESTABLISHED HIERARCHIES AND IS HOMOPHILIC
SOCIAL INSTITUTIONS
Types of parenting

% of respondents self-classifying as lead, dual, and satellite parents

- **Lead parent**: Respondents as the primary caregiver
- **Dual parent**: Share equal parenting roles with either a partner or other (non-partner)
- **Satellite parent**: Partner or other as the primary caregiver
Engaged time
% of respondents self-classifying as lead during particular times

Percentage (%)

Engaged Time
Weekday 6am-9am  Weekday 9am-5pm  Weekday 5pm-8pm  Weekday 8pm-6am  Weekend
Gender
Female  Male
Engaged time
By parenting status
Engaged activities
By parenting status
Dual parents in academic households

Level of agreement with who does majority of childcare

- My partner/other takes on the majority of childcare so I can focus on my career.
- I take on the majority of childcare so that my partner/other can focus on their career.

Dual academic households only

Gender
- Female
- Male
Parenting penalty in production

Log papers by parenting type and gender
Parenting penalty in citation
Factors associated significantly with increased/decreased citations

- Being male
- Taking short parental leave
- Having your partner coordinate playdates
- Not being religious
- Not celebrating holidays
- Traveling (the more, the better)

- Having >2 children
- Taking longer parental leave
- Being the primary OR equal caregiver
- Helping your kids with extracurriculars
- Having young children
  - Dropoff at nursery school
  - Feeding
  - Putting kids to bed
  - Bedtime stories
EXOGENOUS SHOCKS: THE PANDEMIC
Decline in first authors in medRxiv

% of female first authors contributing by platform

- medRxiv
- bioRxiv
- arXiv

- Jul-19
- Aug-19
- Sep-19
- Oct-19
- Nov-19
- Dec-19
- Jan-20
- Feb-20
- Mar-20
- Apr-20

% of female first authors
First vs. last author
Decline in medrxiv
Female participation in COVID research

% of female first authors contributing by platform

% of female first authors

COVID-related

Others

medRxiv
PsyArXiv
SocArXiv
Preprints.org
NBER
bioRxiv
arXiv
Findings from IUB COVID study

Generally speaking, how has your research and creative work productivity changed since the pandemic began in March 2020? [TT only]

- Men: 71%
  - Decreased substantially: 17%
  - Decreased moderately: 7%
  - Decreased somewhat: 12%
  - Remained the same: 8%
  - Increased somewhat: 8%
  - Increased moderately: 12%
  - Increased substantially: 12%
- Women: 84%
  - Decreased substantially: 17%
  - Decreased moderately: 7%
  - Decreased somewhat: 12%
  - Remained the same: 8%
  - Increased somewhat: 8%
  - Increased moderately: 12%
  - Increased substantially: 12%

Generally speaking, how has your work performance changed since the pandemic began in March 2020? [NTT only]

- Men: 45%
  - Decreased substantially: 35%
  - Decreased moderately: 30%
  - Decreased somewhat: 19%
  - Remained the same: 9%
  - Increased somewhat: 31%
  - Increased moderately: 31%
  - Increased substantially: 31%
- Women: 39%
  - Decreased substantially: 35%
  - Decreased moderately: 30%
  - Decreased somewhat: 19%
  - Remained the same: 9%
  - Increased somewhat: 31%
  - Increased moderately: 31%
  - Increased substantially: 31%
Findings from IUB COVID study

1. Mental/emotional health of other people
   - Men: 7% Not at all Challenging, 5% Slightly Challenging, 15% Moderately Challenging, 10% Very Challenging, 12% Extremely Challenging
   - Women: 5% Not at all Challenging, 6% Slightly Challenging, 14% Moderately Challenging, 13% Very Challenging, 13% Extremely Challenging

2. Your childcare responsibilities
   - Men: 13% Not at all Challenging, 8% Slightly Challenging, 16% Moderately Challenging, 10% Very Challenging, 11% Extremely Challenging
   - Women: 9% Not at all Challenging, 7% Slightly Challenging, 10% Moderately Challenging, 12% Very Challenging, 11% Extremely Challenging

3. Your financial stability
   - Men: 63% Not at all Challenging, 11% Slightly Challenging, 14% Moderately Challenging, 10% Very Challenging, 12% Extremely Challenging
   - Women: 59% Not at all Challenging, 10% Slightly Challenging, 12% Moderately Challenging, 11% Very Challenging, 12% Extremely Challenging

4. Your mental/emotional health
   - Men: 14% Not at all Challenging, 6% Slightly Challenging, 13% Moderately Challenging, 11% Very Challenging, 10% Extremely Challenging
   - Women: 6% Not at all Challenging, 6% Slightly Challenging, 12% Moderately Challenging, 12% Very Challenging, 12% Extremely Challenging

5. Your personal relationships
   - Men: 20% Not at all Challenging, 5% Slightly Challenging, 10% Moderately Challenging, 10% Very Challenging, 10% Extremely Challenging
   - Women: 15% Not at all Challenging, 4% Slightly Challenging, 9% Moderately Challenging, 11% Very Challenging, 11% Extremely Challenging

6. Your physical health (including illness)
   - Men: 38% Not at all Challenging, 13% Slightly Challenging, 12% Moderately Challenging, 11% Very Challenging, 10% Extremely Challenging
   - Women: 27% Not at all Challenging, 14% Slightly Challenging, 12% Moderately Challenging, 11% Very Challenging, 11% Extremely Challenging

Not at all Challenging: Not at all Challenging
Slightly Challenging: Slightly Challenging
Moderately Challenging: Moderately Challenging
Very Challenging: Very Challenging
Extremely Challenging: Extremely Challenging
N/A: N/A
Answered: Answered
Findings from IUB COVID study

Finding time to do research
- Men: 9% Not at all Challenging, 91% Extremely Challenging
- Women: 4% Not at all Challenging, 96% Extremely Challenging

Interrupted collaboration with colleagues
- Men: 12% Not at all Challenging, 88% Extremely Challenging
- Women: 7% Not at all Challenging, 93% Extremely Challenging

Limited access to field/clinic/community settings where I do research
- Men: 22% Not at all Challenging, 78% Extremely Challenging
- Women: 11% Not at all Challenging, 89% Extremely Challenging

Limited access to my research lab/facilities
- Men: 14% Not at all Challenging, 86% Extremely Challenging
- Women: 15% Not at all Challenging, 85% Extremely Challenging

Legend:
- Dark blue: Not at all Challenging
- Light pink: Slightly Challenging
- Light red: Moderately Challenging
- Deep red: Very Challenging
- Dark red: Extremely Challenging
- Brown: N/A
- Grey: Answered
Findings from IUB COVID study

Decreased research support from graduate students and/or post-doctoral fellows

- Men: 27% Not at all Challenging, 73% Slightly Challenging, 6% Moderately Challenging, 2% Extremely Challenging
- Women: 19% Not at all Challenging, 81% Slightly Challenging, 7% Moderately Challenging, 1% Extremely Challenging

Decreased research support from undergraduate students

- Men: 34% Not at all Challenging, 66% Slightly Challenging, 4% Moderately Challenging, 2% Extremely Challenging
- Women: 27% Not at all Challenging, 73% Slightly Challenging, 4% Moderately Challenging, 2% Extremely Challenging

Limited access to data analysis support

- Men: 55% Not at all Challenging, 45% Slightly Challenging, 4% Moderately Challenging, 2% Extremely Challenging
- Women: 45% Not at all Challenging, 55% Slightly Challenging, 4% Moderately Challenging, 2% Extremely Challenging

Limited access to research support from staff other than technicians

- Men: 31% Not at all Challenging, 69% Slightly Challenging, 4% Moderately Challenging, 2% Extremely Challenging
- Women: 31% Not at all Challenging, 69% Slightly Challenging, 4% Moderately Challenging, 2% Extremely Challenging

Limited access to research support from technicians

- Men: 34% Not at all Challenging, 66% Slightly Challenging, 2% Moderately Challenging, 1% Extremely Challenging
- Women: 35% Not at all Challenging, 65% Slightly Challenging, 2% Moderately Challenging, 1% Extremely Challenging
PANDEMIC AMPLIFIED PREEXISTING DISPARITIES
BUT DOES IT CHANGE WHAT QUESTIONS ARE ASKED?
Gender as an object of study

Percentage of studies which examine male/female populations

- Biomedical Research
- Clinical Medicine
- Public Health

- No sex
- Both sexes
- Female only
- Male only
Gender as an object of study

Percentage of studies with gender by subdiscipline
Gender as an object of study

Percentage of male/female authors incorporating gender

[Graph showing odds ratios for different categories such as Male-Female, Female-Male, Female-Female, # authors (log2), f_mesh, f_country, Africa, Asia, Europe, Oceania, S. America, and Year across different fields such as All, Biomedical Research, Clinical Medicine, and Health.]
Distribution of topics by race/gender

Topic specialization by feminization and race group proportion (health)
DIVERSIFICATION OF THE SCIENTIFIC WORKFORCE MATTERS
INSTITUTIONALIZING EQUITY
SCIENCE SHOULD BE “FIT” FOR EVERYONE
## Policies across levels

### Other policy alternatives

<table>
<thead>
<tr>
<th>Institutions</th>
<th>P&amp;T Committees</th>
<th>Senior Researchers</th>
</tr>
</thead>
</table>
| - Research assistantships for minoritized communities  
- Incentivize service roles  
- Reconceptualize the ideal worker  
- Provide resources for domestic care | - Recognize heterogeneity in careers  
- Recognize collaboration as essential for innovation  
- Focus on contribution rather than venue  
- Contextualize indicators | - Recruitment and mentoring of minoritized populations  
- Increase transparency in labor and reward  
- Broaden and flatten scientific teams |
THANK YOU!

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