Stresses on the Research Workforce: A Historical Perspective

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NIH Deputy Director for Extramural Research
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Federal Demonstration Partnership
Mayflower Hotel, Washington DC
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Rescuing US biomedical research from its systemic flaws

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Edited by Inder M. Verma, The Salk Institute for Biological Studies, La Jolla, CA, and approved March 18, 2014 (received for review March 7, 2014)

The long-held but erroneous assumption of never-ending rapid growth in biomedical science has created an unsustainable hypercompetitive system that is discouraging even the most outstanding prospective students from entering our profession—and making it difficult for seasoned investigators to produce their best work. This is a recipe for long-term decline, and the problems cannot be solved with simplistic approaches. Instead, it is time to confront the dangers at hand and rethink some fundamental features of the US biomedical research ecosystem.
Why?

POINT OF VIEW

Strategies from UW-Madison for rescuing biomedical research in the US

Abstract A cross-campus, cross-career stage and cross-disciplinary series of discussions at a large public university has produced a series of recommendations for addressing the problems confronting the biomedical research community in the US.

DOI: 10.7554/eLife.09305.001

JUDITH KIMBLE*, WILLIAM M BEMENT, QIANG CHANG, BENJAMIN L COX, NORMAN R DRINKWATER, RICHARD L GOURSE, AARON A HOSKINS, ANNA HUTTENLOCHER, PAMELA K KREEGER, PAUL F LAMBERT, MARSHA R MAILICK, SHIGEKI MIYAMOTO, RICHARD L MOSS, KATE M O’CONNOR-GILES, AVTAR ROOPRA, KRISHANU SAHA AND HANNAH S SEIDEL
Two Core Problems

“Our process identified two core problems that the US biomedical research community faces:
• Too many researchers vying for too few dollars.
• Too many postdocs competing for too few faculty positions.”
Too Many Researchers: Funding Rate for RPGs

- Applicants
- Awardees
- Funding Rate

Number (Thousands) or Percent

Fiscal Year

Too Few Dollars: NIH Budget

The diagram shows the NIH budget over fiscal years from 2000 to 2020, comparing nominal and BRDPI-adjusted funding. The graph indicates a rising trend in both categories, with a notable increase from 2000 to 2004. The BRDPI-adjusted funding shows a more consistent growth compared to the nominal funding, which fluctuates more significantly. The funding is measured in billions of dollars.
Science and Engineering Postdocs

NSF-NIH Survey of Graduate Students and Postdoctorates in Science and Engineering
Too Few Faculty Positions

[Bar chart showing the share of full-time instructional staff change from 1998-2018 for different categories of institutions: R1 Public, R2 Public, R3-M3 Public, BAS Public, R1 Private, R2 Private, R3-M3 Private, BAS Private. The categories are Full Professor, Associate Professor, Assistant Professor, Lecturer, Instructor.]

Andrew Comrie 2021

https://books.openbookpublishers.com/10.11647/obp.0240/ch5.xhtml
Exodus from Academia

Science Ph.D.s increasingly head to industry rather than academia

Percent of science Ph.D.s with jobs lined up, by sector

How Did This Come About?

• NIH budget trajectory
• NIH workforce changes
• Funding inequalities
“But the big problem with a sharp acceleration of spending occurs when it ends. People and projects get caught in the pipeline ... The young people who build their skills as graduate students or postdocs during the acceleration phase of spending bear much of the cost of the deceleration ... The deceleration caused a career crisis for the young researchers ... ”
Career Stage Changes

Percent

Fiscal Year

Early
Middle
Late
Changing Workforce?

Why the US science and engineering workforce is aging rapidly

David M. Blau\textsuperscript{a,b,1} and Bruce A. Weinberg\textsuperscript{a,b,c}

\textsuperscript{a}Department of Economics, Ohio State University, Columbus, OH 43210; \textsuperscript{b}Institute of Labor Economics (IZA), 53113 Bonn, Germany; and \textsuperscript{c}National Bureau of Economic Research, Cambridge, MA 02138

Edited by Shirley M. Tilghman, Princeton University, Princeton, NJ, and approved February 14, 2017 (received for review August 12, 2016)

The science and engineering workforce has aged rapidly in recent years, both in absolute terms and relative to the workforce as a whole. This is a potential concern if the large number of older longitudinal sample survey of the population with a research doctorate in science, engineering, or health, earned in the United States (https://www.nsf.gov/statistics/srvydoctoratework/). We use

“The science and engineering workforce has aged rapidly in recent year, both in absolute terms and relative to the workforce as a whole.”

PNAS 2017; www.pnas.org/cgi/doi/10.1073/pnas.1611748114
The End of Mandatory Retirement for Tenured Faculty

Albert Rees and Sharon P. Smith

Mandatory retirement of tenured faculty in colleges and universities will be abolished on 1 January 1994 by the provisions of the 1986 amendments to the Age Discrimination in Employment Act (ADEA). The passage of this
Biannual Transition Rates in 1993 and 2008

Hazard (Share of Employed Switching to Non-Employment Biannually)

Age

1993

2008
Crowding Out Young Scientists

“Our major findings are that (i) the scientific workforce has aged rapidly ... (ii) the main causes have been a decline in the retirement rate of older scientists, which occurred after the elimination of mandatory retirement in universities, and a convergence ... as the baby boom cohort has aged; and (iii) current trends imply a further substantial increase in the age of the scientific workforce in coming years ...These factors may further crowd out young scientists.”

PNAS 2017; www.pnas.org/cgi/doi/10.1073/pnas.1611748114
A Symptom, Perhaps?

Long-Term Trends in the Age of Principal Investigators Supported for the First Time on NIH R01-Equivalent Awards

By Mike Lauer
Posted November 18, 2021

## Men Age at First RO1 PI’s 1995 - 2020

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Number</th>
<th>Mean</th>
<th>Median</th>
<th>10th Percentile</th>
<th>25th Percentile</th>
<th>75th Percentile</th>
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<td>897</td>
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<td>38</td>
<td>33</td>
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<td>2005</td>
<td>933</td>
<td>42</td>
<td>41</td>
<td>35</td>
<td>38</td>
<td>46</td>
<td>51</td>
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<tr>
<td>2010</td>
<td>1259</td>
<td>43</td>
<td>41</td>
<td>35</td>
<td>38</td>
<td>47</td>
<td>53</td>
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<tr>
<td>2015</td>
<td>1032</td>
<td>43</td>
<td>42</td>
<td>35</td>
<td>38</td>
<td>46</td>
<td>52</td>
</tr>
<tr>
<td>2020</td>
<td>1342</td>
<td>44</td>
<td>42</td>
<td>36</td>
<td>39</td>
<td>47</td>
<td>54</td>
</tr>
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</table>
AAMC Age of First-Time Faculty by Gender and Rank

Click a legend item below to add or remove a line from the report

- First-Time Professors—Men
- First-Time Professors—Women
- First-Time Associate Professors—Men
- First-Time Associate Professors—Women
- First-Time Assistant Professors—Men
- First-Time Assistant Professors—Women
- First-Time Instructors—Men
- First-Time Instructors—Women

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Number</th>
<th>Mean</th>
<th>Median</th>
<th>10th Percentile</th>
<th>25th Percentile</th>
<th>75th Percentile</th>
<th>90th Percentile</th>
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<tbody>
<tr>
<td>1985</td>
<td>10601</td>
<td>44</td>
<td>42</td>
<td>34</td>
<td>38</td>
<td>49</td>
<td>56</td>
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<tr>
<td>1990</td>
<td>12708</td>
<td>46</td>
<td>44</td>
<td>36</td>
<td>39</td>
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<td>59</td>
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<tr>
<td>1995</td>
<td>13987</td>
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<td>46</td>
<td>37</td>
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<td>53</td>
<td>60</td>
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<td>2000</td>
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<td>48</td>
<td>38</td>
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<td>2005</td>
<td>18179</td>
<td>51</td>
<td>50</td>
<td>39</td>
<td>43</td>
<td>57</td>
<td>63</td>
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<tr>
<td>2010</td>
<td>18024</td>
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<td>50</td>
<td>39</td>
<td>44</td>
<td>58</td>
<td>64</td>
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<td>2015</td>
<td>17934</td>
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<td>51</td>
<td>39</td>
<td>44</td>
<td>59</td>
<td>66</td>
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<tr>
<td>2020</td>
<td>20775</td>
<td>53</td>
<td>51</td>
<td>40</td>
<td>44</td>
<td>60</td>
<td>68</td>
</tr>
</tbody>
</table>
Age RPG PI’s (Mean) by Gender
Age RPG PI's (90th %ile) by Gender

Fiscal Year
1985
1990
1995
2000
2005
2010
2015
2020

Age (Years)
30 40 50 60 70

Women
Men

(Area plots showing age distribution of RPG PI's by gender from 1985 to 2020, with each year depicting the 90th percentile age distribution for women and men.)
“But the big problem with a sharp acceleration of spending occurs when it ends. People and projects get caught in the pipeline ... The way agencies divide budgets between the number and size of research grants will affect researchers’ behavior and thus research output ...”
RPG Awards / PI's

Number (Thousands)

Fiscal Year

Awards
Principal Investigators
“... NIH funding has been marked by high inequality (elite investigators and institutes get the lion’s share of resources) and decreased mobility (those who start at the bottom are less likely to rise to the upper ranks). Elite investigators and institutes currently produce the bulk of prestigious publications, citations, and patents that commonly used metrics valorise.”
Inequalities in RPG Funding

Inequalities in the distribution of National Institutes of Health research project grant funding

Michael S Lauer¹*, Deepshikha Roychowdhury²

¹National Institutes of Health, Office of the Director, Bethesda, United States; ²NIH Office of Extramural Research, Bethesda, United States

Monies to the Top 1%
The Next Generation Researchers Initiative at NIH

Michael Lauer*,1, Lawrence Tabak*, and Francis Collins*

Growing concerns about the wellbeing and stability of the biomedical research workforce are well documented. Over the last 15 years (since the end of the doubling of the NIH budget), we have observed worsening “hypercompetition” as more scientists vie for fewer available dollars (1, 2). Within this hypercompetitive environment, the research workforce is growing older at a rate that is disproportionate to the general American labor force (3). Late-career investigators have been awarded a greater proportion of available research funding, raising concerns that early-career investigators risk being crowded out of the workforce before they have a chance to launch independent scientific careers (3). Other analysts have suggested that adverse effects are also being felt by midcareer investigators (4); large numbers of meritorious investigators may achieve research independence only to lose it because they are unable to renew their one grant or obtain a second new grant.

In our latest effort to tackle this problem, the NIH is...
## Who Are the Top 1%?

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Top 1%</th>
<th>Bottom 99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N (%)</td>
<td>349 (1.0)</td>
<td>34587 (99.0)</td>
</tr>
<tr>
<td>Career Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>30 (8.6)</td>
<td>10567 (30.6)</td>
</tr>
<tr>
<td>Middle</td>
<td>128 (36.7)</td>
<td>12936 (37.4)</td>
</tr>
<tr>
<td>Late</td>
<td>162 (46.4)</td>
<td>8273 (23.9)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>241 (69.1)</td>
<td>21695 (62.7)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>277 (79.4)</td>
<td>23264 (67.3)</td>
</tr>
<tr>
<td>Degree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td>166 (47.6)</td>
<td>24620 (71.2)</td>
</tr>
<tr>
<td>MD</td>
<td>116 (33.2)</td>
<td>5238 (15.1)</td>
</tr>
<tr>
<td>MD-PhD</td>
<td>60 (17.2)</td>
<td>3572 (10.3)</td>
</tr>
</tbody>
</table>
### Funding for the Top 1%

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Top 1%</th>
<th>Bottom 99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N (%)</td>
<td>349 (1.0)</td>
<td>34587 (99.0)</td>
</tr>
<tr>
<td>Funding in $Million</td>
<td>Median (IQR)</td>
<td>4.8 (4.0 to 6.5)</td>
</tr>
<tr>
<td>RPG Awards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>69 (19.8)</td>
<td>23268 (67.3)</td>
</tr>
<tr>
<td>Two</td>
<td>86 (24.6)</td>
<td>7571 (21.9)</td>
</tr>
<tr>
<td>Three</td>
<td>52 (14.9)</td>
<td>2540 (7.3)</td>
</tr>
<tr>
<td>Four</td>
<td>60 (17.2)</td>
<td>847 (2.4)</td>
</tr>
<tr>
<td>Five or More</td>
<td>82 (23.5)</td>
<td>361 (1.0)</td>
</tr>
</tbody>
</table>
“In this cross-sectional study of NIH investigators from 1991 to 2020, we found a growing gap among NIH investigators that created a cohort of highly funded NIH investigators. Importantly, there were persistent gender, ethnic, and racial inequities among this elite class of SPIs.”
PI’s Multiple Grants

4 or more grants

6.4×

Percentage of all PIs

Fiscal year

1990  2000  2010  2020

“But the big problem with a sharp acceleration of spending occurs when it ends. People and projects get caught in the pipeline ... The way agencies divide budgets between the number and size of research grants will affect researchers’ behavior and thus research output ...”
National Institutes of Health research project grant inflation 1998 to 2021

Michael S Lauer¹*, Joy Wang², Deepshikha Roychowdhury²

¹National Institutes of Health Office of the Director, Bethesda, United States;
²National Institutes of Health Office of Extramural Research, Bethesda, United States

Lauer et al. eLife 2023;12:e84245. DOI: https://doi.org/10.7554/eLife.84245
RPG Mean Costs

Lauer et al. eLife 2023;12:e84245. DOI: https://doi.org/10.7554/eLife.84245
More Solicited RPG Projects

- Solicited Funding
- Solicited Projects

Graph showing the increase in solicited funding and projects over fiscal years from 2000 to 2020.
Summary

• Development of hypercompetitive environment
• Too many scientists and too many post-docs
• Budget oscillations have lasting effects
• Aging workforce crowds out earlier career scientists
• Funding inequalities exacerbate hyper-competition
“This report by my Science Advisory Committee ... I hope it will be well received ... In this great endeavor, the partnership between the Government and the nation’s universities will assume growing importance ...”

Dwight Eisenhower

The White House
November 17, 1960

https://babel.hathitrust.org/cgi/pt?id=uiug.30112305092057;view=1up;seq=1
Concerns ...

“Many are strongly opposed to the use of Federal funds for senior faculty salaries ... Need for avoiding situations in which a professor becomes responsible for raising his own salary ... A most unsatisfactory sort of ‘second class citizenry‘ is created, and we are firmly against this sort of thing.”

President’s Science Advisory Committee
November 15, 1960
What Happened ...

“The establishment binged on hiring a second class of researchers ... The result was to create demand for Federal funds that outstripped cash supply ... Encouraged by fiscal surges, science created a bubble.”

Roberta Ness
U of Texas (Houston)

Oxford University Press, 2015, page 41
Possible Approaches

• Fund more early career investigators
• Fund more at-risk investigators
• Cap funding available per investigator
• Reduce numbers of trainees and post-docs
• Encourage alternate career pathways
• Other