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before the

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Subcommittee on Research and Technology
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The Impact of the COVID-19 Crisis on University Research

Chairwoman Stevens, Ranking Member Baird, and members of the subcommittee — thank you for inviting me to address the devastating impacts of the pandemic on the university research enterprise, and ways in which Congress can redress that impact. This committee has provided tremendous, bipartisan leadership on these issues and includes many of the leading voices in Congress on the importance of basic research to our country's future.

I serve as the Interim Vice President for Economic Development and Innovation of the University of Illinois System, which is the state's largest system of higher education, with more than 89,000 students at three universities in Urbana-Champaign, Chicago, and Springfield. I am also a Senior Fellow at the Association of American Universities (AAU), which is composed of the nation's leading research universities. Since the pandemic started, AAU has worked to assess research impacts, challenges, and opportunities, and to illuminate the need and advocate for a strong federal response.

As I will discuss in my testimony that response should include passage of the Research Investment to Spark the Economy (RISE) Act (H.R. 7308), which authorizes research relief funds for the federal research agencies, as well as the Early Career Researchers Act (H.R. 8044) which addresses the unequal impacts the pandemic has had on researchers at the start of their careers. I thank the members of this committee who are spearheading these important legislative efforts and for explicitly including these bills in the charter of today's hearing. It is critical that Congress act soon to implement the provisions of the RISE Act and Early Career Researcher Act by approving supplemental funding to federal research agencies to ameliorate the harmful disruptions to research and the research workforce that I discuss below.

In my testimony, I will discuss: (1) the impact of the pandemic on research activities; (2) current challenges facing universities and research laboratories; (3) general impacts of delays on researchers; (4) the unequal impact on certain categories of researchers including students and trainees; and (5) the need to take federal action to maintain the position of the U.S. research enterprise and the economic and workforce benefits it provides.

Impact on Research Activities

In March, to protect the health and safety of their students, employees, and surrounding communities, universities across the United States shut down on-campus operations. Students departed and classes for the remainder of the academic year were conducted remotely at nearly

all universities. The shutdown of research was similarly significant. The institutional change was well-described by Wigginton *et al*¹, detailing how extensively and rapidly research operations were transformed. By most estimates, in the early spring of 2020, approximately 80 percent of all research was significantly slowed or stopped. Researchers could analyze previously collected data, write reports and manuscripts, and plan for next steps; but then productivity dropped significantly. Nearly all lab-based research, social science, education-related, and health-related research as well as almost all field-based research was seriously impacted. Typically, the only on-campus research that continued was that which was considered essential, such as research associated with the pandemic. Activity also continued where it was critical to maintain equipment, vital cell and animal lines, as well as some long-term studies, and some patient-related research.

It is worth highlighting the significant ways in which universities have helped provide solutions specific to the pandemic. Researchers published thousands of papers and posted preprints online on a timeline that defied the usual pace of academic publications. In this way, academic researchers provided the public with vital information in an impressively rapid fashion. This information was critical to our nation's response to the pandemic during the initial wave of transmission and continues to be vital as we mitigate spread, respond to flare-ups, and better diagnose and treat COVID-19. Researchers also developed innovative and cost-effective means to manufacture personal protective equipment (PPE), such as faceguards, and lifesaving equipment, such as ventilators. They also developed new diagnostics and therapeutics in record time.

At all universities, there was an immediate pivot to find a path to fulfilling the tripartite mission of teaching, research, and service. Faculty and staff efforts were tremendous. New modes of teaching and new educational technologies were implemented with speed and at scale. Service activities pivoted to online modes. And researchers nationwide engaged in means to use their expertise to bring teaching and research back to campus. Much of that effort was local, e.g., bringing a laboratory or department back toward fuller activity; however, some of the activity was broader. At the University of Illinois Urbana-Champaign, a convergence of faculty from numerous disciplines developed a sensitive and specific saliva-based test for SARS-CoV-2 that is now being used at high frequency (everyone on-campus, approximately 35,000 people, is being tested twice per week) with actionable turnaround times as part of an entire program of mitigation that is founded on epidemiologic modeling and technology-driven communications. All of this is scalable at entities beyond academia. This is but one example of how universities have used the multidisciplinary resources uniquely embedded in their faculty and staff to focus on fulfilling their mission as an institution of higher education. We are also witnessing how research activities initiated on-campus are being extended beyond the campus to help institutions and companies navigate the pandemic, thereby advancing the economy and the health of the nation.

For more examples of work done by universities to respond to the pandemic, please see Appendix A.

In late spring, university researchers cautiously started returning to campuses. They did so while implementing now well-accepted principles: wearing masks to mitigate the spread of the virus borne within respiratory droplets and aerosols, socially distancing by limiting the number of people in a building or a research space, implementing around the clock scheduling, increasing hygiene such as hand washing, and checking regularly for signs and symptoms of COVID-19.

¹ See Appendix B

The return to campus by researchers was a huge effort for the faculty, staff, and students. It required changes in practices by all involved – from the faculty and students, to the support staff and facilities personnel. It required serious introspection regarding safety and risk tolerance by all who have returned to campus – everyone needed to feel that they would be safe. But universities felt that it was important for researchers to be able to ramp up the activity that is vital to the creation of new knowledge and is undisputedly an engine for the U.S. economy. Anecdotal evidence indicates that the transmission of SARS-CoV-2 in the research environment is rare, which is unsurprising given the safety culture that pervades research.

As we enter late summer, most on-campus research laboratories are operational, but with social distancing limiting the number of researchers in a lab space at any time – each aware of their distance relative to others. Working multiple shifts and coordinating carefully, most laboratories can make progress, but not at the usual pace. Some field work has restarted; most international collaborations remain remote. Human-subjects research in the medical sciences is returning; but in-person human-subjects work in the social sciences remains largely stagnant.

COVID-19 has disrupted all social activities, and that includes research, which, despite popular misconceptions, depends on social interactions. Researchers continually learn from one another in formal settings such as at lab group meetings, seminars, and conference presentations as well as during informal interactions in the laboratory or hallway, or at coffee breaks during conferences. Collaborations and regular discussions are vital to the creation of new knowledge. The mitigation activities, especially the social distancing, disrupt these exchanges, slow the progress of research, and have significant near- and long-term impacts.

While the evidence indicates that by implementing mitigation strategies (masking, distancing, etc.) there is little spread of SAR-CoV-2 in research environments, there are significant challenges that universities and researchers are facing.²

Current Challenges Facing Universities and Researcher Labs

University financial and personnel resources are strained at this time. Beyond the strain that is visible to the public due to changes in undergraduate education, the late spring ramp-up of research required investment by every university: from PPE to hand sanitizer, from increased access to information technology (IT) services to new computer systems for remote workers, from one-way hallways to more regular and deeper cleaning of nearly every space on campus. The list of new processes is long; the costs are significant and are being borne by internal university funds.

One set of costs of particular importance to research are those associated with core university research facilities with shared scientific instrumentation. Nearly every researcher uses such core facilities, which include high performance computers, specialized microscopes, nanofabrication labs, and vivariums. Research often cannot be conducted without these facilities. Core university research facilities are critical to innovation, our economic vitality, and our national security. The financing of “core facilities” is from fees paid from grant funds by users; e.g., when a graduate student research assistant uses an electron microscope to study the surface of a virus, grant funds are used to pay the costs of using that microscope. During the shutdown and even now when activity is less than 100%, researchers are not using these

² See Appendix C

facilities fully, user fees are not being collected as they were before the pandemic, and thus university funds must be used to maintain the existence of the core facilities. If a university is unable to maintain a core facility, then part of the cornerstone of the nation's research infrastructure is lost.

Many research universities have committed resources to maintain their world-class research facilities through the time of the pandemic. This is unsustainable. While the federal government and many private sponsors modified grant conditions to allow continued support of personnel paid from a grant during the early stages of the pandemic when research was paused, funds for core facilities did not continue to flow. Recovery from the pandemic should include federal funds that allow for the sustainability of university core facilities and other key components of the research infrastructure of the United States that are operated by research universities.

General Impacts of Research Delays

The progress toward completion of funded research has been slowed or halted for most researchers in the U.S. Every faculty member conducting research can be considered an entrepreneur. Effectively they are the sole proprietor of a small business: their research group. They all have a vision for their work and drive forward on that vision. They produce two key products: new knowledge and graduates. That new knowledge expands our understanding of the world in which we live and, periodically, results in new products or processes that are the basis for new companies, an expanded economy, and enhanced national security. Those new graduates go on to produce discoveries or propel companies for a lifetime and thus are an incredible return on the research investment. During the pandemic, however, most of these "small business owners" – the researchers – have had their activity seriously derailed, often being at least temporarily halted in their regular operations. Some actually regressed. A few proceeded unaffected. And others started a new line of activity related to COVID-19.

Those who faced pauses in regular activities, i.e., the vast majority, will be challenged to reach the expected research milestones in the timeframe that was proposed to their federal research sponsors. No-cost extensions to their grants will help these researchers, but unforeseen new delays due to the pandemic will limit their ability to reach their goals – unless supplemented, their funds could be expended before their research is complete. All research that leads to societal impact, such as the discovery of a new treatment for cancer or of new methods in artificial intelligence, involves a series of steps. It requires funding over many years, sometimes decades. The disruption of the pandemic, without supplemental support from the federal research sponsors, will break this continuum and at best delay results; in many cases, it can indefinitely halt otherwise productive lines of work.

Some researchers have experienced regression in their research. If a researcher was doing a longitudinal study that was stopped during the pandemic, then not only does that study need to restart, it may need to restart at the beginning of the study so there is continuity of data collection. Some researchers were preparing for seasonal field work, e.g. in agricultural areas or environmental sciences; for these researchers, a year has been lost and hole in the data will be harmful in most cases. The graduate students and post-doctoral fellows in these areas have experienced a halt to their career progress; for some, the path forward is not clear since their salary funding is available only for a defined period of time, which may no longer be sufficient to complete their research.

A few researchers barely paused during the pandemic. As an example, some computational scientists continued their work unabated. Indeed, with less travel to conferences and invited

seminars, they may have been able to focus more on creation of new knowledge and less on dissemination of that knowledge. Such has been the heterogeneity of the impact of COVID-19.

In a related way, the strain of the pandemic and the delays this strain is causing on our pursuit of new and impactful knowledge is impacting our global competitiveness.

Unequal Impacts on Certain Researchers

The pandemic has been particularly harmful to some researchers, independent of their research specialties. For example, early career faculty are on a tenure track that has a limited time frame. Most universities have provided an additional year to all those who are in their pre-tenure, probationary period. This is absolutely the right decision, but we can expect that there are differential impacts of such measures. A study I coauthored recently on [Unequal effects of the COVID-19 pandemic on scientists](#), attached as Appendix C, found that researchers with children at home have had larger barriers to their productivity, especially when daycare availability has been limited and when primary and secondary schools are delivering education online. This impact falls disproportionately on women. Further, with most universities severely limiting faculty hiring this year, career advancement for post-doctoral fellows is slowed. One can foretell the cascade of negative impacts: graduating graduate students see fewer post-doctoral position openings and delay moving on, and thus new graduate students face laboratories with fewer funded positions that are open.

Data from the University of Michigan's Institute for Research on Innovation and Science indicate the majority (53%) of the scientific workforce at universities who receive funding from federal research funds are students or trainees, including post-doctorates.³ With research grants depleted by productivity drops during the pandemic, it is critical to provide additional support for this vulnerable group of researchers, i.e. those early in their career. Support for graduate students and post-doctoral fellows can have a multiplier effect throughout the ecosystem and propel a generation of young researchers into long careers of consequence. That is why it is so important that we provide graduate students and post-docs with additional support now and seek to mitigate the adverse consequences of the pandemic on their careers. I am pleased that members of this Committee recently introduced the Supporting Early-Career Researchers Act, H.R. 8044, to help address the unequal impacts the pandemic has had on researchers at the start of their careers.

Further, researchers who would be susceptible to COVID-19, such as those with health risks and those sharing living or working spaces with vulnerable people, could find it difficult to return to research activities. Also, researchers who are socio-economically disadvantaged may be differentially impacted by the pandemic because they do not have the resources that allow them to work effectively away from campus or respond promptly to the challenges encountered during a pandemic.

Lack of support for specific groups could differentially impede researchers who are in a vulnerable stage of their careers and have long-term impact on efforts to diversify the academy.

Federal Action Needed

It is for these reasons that the federal government needs to act now to address the pandemic's harmful impacts on research. Research relief funding for the nation's science agencies is

³ https://iris.isr.umich.edu/wp-content/uploads/2020/04/IRISresearchspendingfactsheet4-20_final.pdf

needed to maintain the vital continuity of the research across a breadth of disciplines, to maintain the flow of talent from within the U.S. and to the U.S., and to continue to fuel the engine of innovation vital to national prosperity and security. Foreign government investment in research has not abated. In fact, in many countries the investment continues to increase greatly. In addition to the Supporting Early-Career Researchers Act, Congress should take up and pass the RISE Act, H.R. 7308. As AAU, the Association of Public and Land-grant Universities, the Association of American Medical Colleges, and the American Council on Education wrote to Congress in May, “COVID-19 has caused enormous disruptions to federally supported research and inflicted serious and detrimental impacts on our nation’s research enterprise.” The bipartisan and bicameral (S. 4286) RISE Act authorizes approximately \$26 billion in supplemental funding for federal research agencies to ameliorate the tremendous disruption to federally funded research, while also providing temporary regulatory relief. I am encouraged by the support of 126 House Members so far and more than [300 organizations](#) that have cosponsored or endorsed the RISE Act, including the University of Illinois System and AAU.

As researchers and universities face challenges to their operations incurred by the pandemic⁴, it is crucial to provide support so the U.S. can maintain its prominent position in research. Without supplemental funding from Congress for research relief, the consequences for our nation’s university research and scientific enterprise will be dire. In the coming months, federal agencies will be forced to choose between abandoning new research opportunities of national importance or discontinuing existing research projects that are not yet completed. The latter would undermine investments the public has already made in research and either approach will slow discovery and innovation, while at the same time jeopardizing a generation of scientists and engineers critical to America’s innovation capacity and economic competitiveness for years to come.

The near-term impacts of the COVID-19 crisis on the U.S. academic research enterprise are clear, as indicated above. We can foresee that the long-term impacts are likely to be serious and harmful. That is why I urge members of this subcommittee to help ensure that their congressional colleagues understand the need for urgent action. U.S. research universities and, very importantly, the visionary researchers within those universities are assets that the American public has leveraged for generations. The federal government recognized these assets decades ago when forging the modern [government-university research partnership](#) to advance our nation’s health, economic, and national security. The universities and their researchers have stepped forward during the pandemic to help us understand the virus and the disease it causes. They prudently shut down operations, and then as soon as feasible they deliberately, safely, and successfully ramped up their research activities. The universities and their researchers are working to weather the setbacks caused by the pandemic. But they cannot do it alone. With the support of Congress, federal research conducted at America’s universities and by the researchers who innovate there will emerge from the pandemic with the strength and vigor that has been the hallmark of the U.S. research enterprise for decades.

Thank you again for the opportunity to testify, and I look forward to your questions.

⁴ See Appendix D

Appendices:

Appendix A: Examples of university efforts to advance COVID-19 research

Appendix B: Wigginton NS, Cunningham RM, Katz RH, Lidstrom ME, Moler KA, Wirtz D, Zuber MT: Moving academic research forward during COVID-19. *Science* Vol 368, pp.1190-1192, 12 June 2020.

Appendix C: Myers KR, Tham WY, Yin Y, Cohodes N, Thursby JG, Thursby MC, Schiffer P, Walsh JT, Lakhani KR, and Wang D: Unequal effects of the COVID-19 pandemic on scientists, *Nature Human Behavior*, 2020. <https://doi.org/10.1038/s41562-020-0921-y>

Appendix D: Schiffer P, Walsh J: The research ecosystem has undergone a complex transformation, necessitating a multifaceted response. *Inside Higher Ed* 5 Aug 2020.

Appendix A

Examples of university efforts to advance COVID-19 research (<https://www.aau.edu/research/featured-research/battling-covid-19>)

Institution	Title	Summary	Link
Boston University	Tiny, Decoy “Sponges” Attract Coronavirus Away from Lung Cells	New nanotechnology tested at BU’s NEIDL stops SARS-CoV-2 from infecting cells and replicating	https://www.aau.edu/research-scholarship/featured-research-topics/tiny-decoy-sponges-attract-coronavirus-away-lung
Rutgers University	Asthma Does Not Seem to Increase the Severity of COVID-19	Rutgers researchers say further study is needed but those with the chronic respiratory disease don’t appear to be at a higher risk of getting extremely ill or dying from coronavirus	https://www.aau.edu/research-scholarship/featured-research-topics/asthma-does-not-seem-increase-severity-covid-19
University of Illinois	Scientists develop rapid saliva test	The University of Illinois Urbana-Champaign is testing up to 20,000 students and staff daily using a saliva test it developed that typically provides results within hours.	https://emails.illinois.edu/newsletter/250894814.html
University of Oregon	New research examines the societal effects of COVID-19	UO researchers trying to learn more about how the coronavirus pandemic has affected daily life are teaming up to explore how people get groceries and household provisions and how that is changing travel and transportation.	https://www.aau.edu/research-scholarship/featured-research-topics/new-research-examines-societal-effects-covid-19
Iowa State University	Chemists at Iowa State University are developing a paper-strip urine test to detect infection by the coronavirus that causes COVID-19.	Chemists developing paper-strip urine test for at-home/office/clinic COVID-19 evaluation	https://www.aau.edu/research-scholarship/featured-research-topics/chemists-developing-paper-strip-urine-test
University of Southern California	USC researchers bioengineer first-line defense against COVID-19	Researchers at the USC Dr. Allen and Charlotte Ginsburg Institute for Biomedical Therapeutics, the USC Institute for Technology and Medical Systems and the USC School of Pharmacy are developing an antimicrobial fluid to bolster the body’s first-line defenses against COVID-19.	https://www.aau.edu/research-scholarship/featured-research-topics/usc-researchers-bioengineer-first-line-defense
University of Utah	COVID-19 causes ‘hyperactivity’ in blood-clotting cells	Changes in blood platelets triggered by COVID-19 could contribute to the onset of heart attacks, strokes and other serious complications in some patients who have the disease, according to University of Utah Health scientists.	https://www.aau.edu/research-scholarship/featured-research-topics/covid-19-causes-hyperactivity-blood-clotting-cells

Stony Brook University	Machine Learning Can Identify Areas Most at Risk from Pandemic	Areas most at risk from the COVID-19 pandemic can be identified by a new machine learning tool developed by researchers at startup company Akai Kaeru LLC, which is affiliated with Stony Brook University's Department of Computer Science and the Institute for Advanced Computational Science.	https://www.aau.edu/research-scholarship/featured-research-topics/machine-learning-can-identify-areas-most-risk
Pennsylvania State University	Online dashboard enables COVID-19 tracking by Pennsylvania county	Residents of Pennsylvania can monitor the spread of COVID-19 across the commonwealth with an online dashboard created by researchers at Penn State. The dashboard, which has been available since March 12, provides a map of the state with the number of confirmed COVID-19 cases represented by county	https://www.aau.edu/research-scholarship/featured-research-topics/online-dashboard-enables-covid-19-tracking
University of Washington	UW launches online training for contact tracing to help fight COVID-19	University of Washington created the free, online course Every Contact Counts to support public health agencies in their contact tracing efforts	https://www.aau.edu/research-scholarship/featured-research-topics/uw-launches-online-training-contact-tracing-help
Northwestern University	Northwestern team develops new antibody test for COVID-19	Northwestern University researchers have developed a new method for testing for SARS-CoV-2 (the virus that causes COVID-19) antibodies. The method requires only a single drop of blood collected from a simple finger prick.	https://www.aau.edu/research-scholarship/featured-research-topics/northwestern-team-develops-new-antibody-test-covid-19
University at Buffalo	In three languages, Berry Bunny teaches kids about coronavirus	How should children learn about COVID-19? Two University at Buffalo medical students created an adorable, original character named Berry Bunny to explain coronavirus to kids in a clear, colorful and easy-to-understand story, complete with illustrations and activities.	https://www.aau.edu/research-scholarship/featured-research-topics/three-languages-berry-bunny-teaches-kids-about
Michigan State University	Study: How To Identify Patients Most At Risk From COVID-19 Through Nanotechnology	A Michigan State University professor proposed a point-of-care diagnostic platform that uses either nanoparticles or magnetic levitation to diagnose infection and assess future risk.	https://www.aau.edu/research-scholarship/featured-research-topics/study-how-identify-patients-most-risk-covid-19
The Ohio State University	Glacial ice will likely hold records of the COVID-19 pandemic, researchers say	Ice from glaciers around the world, undisturbed for centuries, show changes in how societies functioned throughout history – and will likely hold a record of the current impact of the COVID-19 pandemic for future generations.	https://www.aau.edu/research-scholarship/featured-research-topics/glacial-ice-will-likely-hold-records-covid-19
University of Pittsburgh	Formula Developed to Combat HIV Could Work as Novel Coronavirus Preventive	A nasal spray derived from algae and a plant in the tobacco family could offer a preventive measure for COVID-19, per Pitt researchers.	https://www.aau.edu/research-scholarship/featured-research-topics/formula-developed-combat-hiv-could-work-novel

University of Florida	Developing a next-generation coronavirus test for home use	UF researchers are working on a simple, paper-based system that would make it possible to test for the novel coronavirus in your own home.	https://www.aau.edu/research-scholarship/featured-research-topics/developing-next-generation-coronavirus-test-home-use
University of California, Irvine	Chemistry faculty launch antiviral research project	Scientists combine their diverse skills in collaborative effort to hobble COVID-19	https://www.aau.edu/research-scholarship/featured-research-topics/chemistry-faculty-launch-antiviral-research-project
University of Rochester	Rochester researchers pursue quick ways to detect COVID-19 — and better understand it	Scientists at the University of Rochester are rapidly adapting previous research to develop tests to detect the fast-spreading disease.	https://www.aau.edu/research-scholarship/featured-research-topics/rochester-researchers-pursue-quick-ways-detect-covid
Emory University	Emory develops diagnostic antibody blood test to determine antibody-responses to COVID-20	Emory University has developed a sensitive and specific diagnostic antibody blood test that will help determine antibody responses in people who have been infected by COVID-19.	https://www.aau.edu/research-scholarship/featured-research-topics/emory-develops-diagnostic-antibody-blood-test
Duke University	Duke Creates Open-Source Protective Respirator	A protective respirator created by a Duke University medical and engineering task force is now being used by Duke Health doctors as they treat patients with suspected cases of COVID-19.	https://www.aau.edu/research-scholarship/featured-research-topics/duke-creates-open-source-protective-respirator
Brandeis University	Brandeis researchers tackle COVID-19	Virologist Tijana Ivanovic's lab is looking at how the virus infects cells. Computer scientists Pengyu Hong and Hongfu Liu are using machine learning to map its genetic code.	https://www.aau.edu/research-scholarship/featured-research-topics/brandeis-researchers-tackle-covid-19
Johns Hopkins University	Antibodies from COVID-19 survivors could be used to treat patients, protect those at risk	With a vaccine for COVID-19 still a long way from being realized, Johns Hopkins immunologist Arturo Casadevall is working to revive a century-old blood-derived treatment for use in the United States in hopes of slowing the spread of the disease.	https://www.aau.edu/research-scholarship/featured-research-topics/antibodies-covid-19-survivors-could-be-used-treat

POLICY FORUM

RESEARCH POLICY: COVID-19

Moving academic research forward during COVID-19

A gradual, stepwise approach to reopening, informed by public health expertise, will be essential

By N. S. Wigginton^{1,2}, R. M. Cunningham¹, R. H. Katz³, M. E. Lidstrom⁴, K. A. Moler², D. Wirtz⁵, M. T. Zuber⁶

The coronavirus disease 2019 (COVID-19) pandemic has led to an unprecedented disruption of society. Institutions of higher education have been no exception. To preserve the safety of their communities and adhere to public health guidance, universities and colleges around the world have rapidly pivoted to fully online teaching and learning models, implemented remote work for the majority of employees, and shuttered countless public spaces and programs. Most “on-site” research activities—in laboratories, in clinics, or in the field—also ground to a halt. Many institutions are now planning or implementing a ramp-up of on-site research activities, which offers an opportunity to begin implementing policies and practices that will lay the groundwork for the eventual reopening of additional on-site academic programming, including teaching. To ramp up safely, institutions are working with stakeholder groups—such as public health experts, as well as faculty, staff, and students—to develop guiding principles that will help inform and drive decision-making over the coming months. We synthesized several risk and decision-making frameworks under development at our universities to develop a set of criteria informed by public health expertise that institutions should consider before and during the first stages of restoring research activities and less certain factors to consider for subsequent phases.

Ramping down academic research and development around the world will undoubtedly contribute to the long-term economic ramifications of COVID-19. In addition

to supporting the teaching and service missions of higher education—and health care delivery within academic medical centers—academic research contributes greatly to global economic development. In the United States, for example, higher education institutions accounted for \$74 billion, or ~13%, of the \$580 billion spent nationally on research and development in 2018 (1). More critically, these same institutions accounted for nearly half of the \$96 billion spent on basic research nationwide, often seen as the seed corn for innovation and industry. Moreover, academic research institutions are among the top five employers in 44 of 50 U.S. states, employing more than 560,000 people (and more than 300,000 trainees) directly on research funds (2), many of which cannot perform their work remotely.



Markings are placed on the floor of an empty lab to promote social distancing.

RAMPING DOWN

Public health mitigation strategies across the globe have affected on-site research to varying degrees. In China, university research was subject to strict control measures in Wuhan and elsewhere, which contributed to the mitigation of the spread of the virus across the country (3). In Australia, where COVID-19 remains under greater control owing to early mitigation efforts, universities moved classes online, but social distancing measures and encouraging nonessential work from home when possible were deemed sufficient to keep most research facilities at least partially open.

In countries and regions where community transmission has been most severe—including the United States, Europe, and China—most academic institutions implemented policies to cease all “nonessential” on-site research activities over a short time frame, in some cases just a few days. This included not only laboratory research in the physical and life sciences but also field-based activities involving travel or direct human contact, such as clinic-based health, social, or educational research. Exemptions for accessing facilities on campus were solely made for work required to maintain equipment, preserve specialized research materials or long-term experiments, perform research to address the ongoing pandemic or other research deemed essential, or ensure patient, animal, and laboratory safety. Although varying widely by discipline and region, we estimate that these restrictions have halted more than 80% of on-site research activity at our six institutions.

RAPID RESPONSE

Despite the myriad challenges associated with ramping down on-site activities, research institutions worked closely with state and federal governments, funders, private industry, and each other to maintain continuity of research operations. In the United States, universities and their associations have been working closely with federal agencies to clarify what activities are allowed under active grants (e.g., salary continuity for researchers who aren’t able to work on-site). Other coordination efforts include commitments to open sharing of data and research findings during the pandemic (4), improving access to high-performance computing resources for COVID research (5), and licensing terms that prioritize access to potentially life-saving technologies (6).

Academic researchers have also greatly contributed to work that directly addresses the ongoing pandemic—from revealing the fundamental biology of severe acute respiratory syndrome–coronavirus 2 (SARS-CoV-2), to studying the vast social, behavioral, and

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Phased approach and possible mitigations for determining allowable on-site research

	COMMUNITY TRANSMISSION STATUS (15)	ON-SITE ACTIVITIES PERMITTED	MITIGATIONS	RESEARCH WORKFORCE IMPLICATIONS
Phase 0 (current state)	Substantial	Only essential work to ensure laboratory, animal, or patient safety; maintenance of equipment, materials, or long-running experiments; COVID-related research	Strict building access; personal protective equipment required; all work done remotely, if possible	Only essential staff with considerable training allowed; travel disrupted; substantial absenteeism owing to illness, child care, or family care; high-risk workers restricted
Phase 1 (ramp-up)	Moderate	Gradual addition of laboratory and studio work and regional field research not involving human subjects; widely used shared facilities reopen	Control building and/or room access; require temperature and symptom checking, physical distancing, strict limits on occupancy in labs, use of masks, enhanced cleaning procedures, and closures of exposed work spaces and buildings; testing and contact tracing if and when available	Fraction of researchers allowed depending on need, training, and willingness to return
Later phases	Minimal to none	Continued gradual addition of more on-site research activities, use of office and shared spaces, and relaxation of travel prohibitions; research with human subjects will require the highest level of scrutiny	Gradual loosening of some control measures, depending on performance metrics	Phased introduction of researchers working in-person with human subjects; additional trainees; high-risk workers only when conditions allow

economic impacts felt across the world, to developing the tests, therapies, and vaccines that will help treat the disease and prevent its transmission. Researchers around the globe have published more than 13,700 papers on SARS-CoV-2 or COVID-19 (7) and posted more than 3700 preprints to the bioRxiv and medRxiv repositories as of 19 May 2020.

Institutions are also assisting with critical public health services such as testing and providing the public and decision-makers with real-time data about the pandemic. For example, Johns Hopkins University's international COVID-19 dashboard receives 1.5 billion views each day, providing invaluable data on total confirmed cases, deaths, recovery rates, bed occupancy, intensive care unit availability, and more (8). Overall, the collaborations and open sharing of data and knowledge across international borders have proven to be essential in the response to the pandemic and to the reopening of other economic sectors.

GUIDANCE FOR PHASED RAMP-UP

Months after most on-site research was shut down, institutions in China, Europe, and the United States have slowly started resuming on-site research. Institutions have developed principles and policies for resuming on-site research activities based on input from public health and biosecurity experts, faculty, staff, students, and other community members. Our six universities, which represent a range of public and private institutions under varying state and local mandates and levels of local virus transmission, have developed overlapping yet distinct guidance for our research communities (see <https://doi.org/10.3886/E119503V1>). Common themes within our plans and elsewhere center around the critical need to adhere to public health guidance, prioritize the health and safety of the workforce and participants, and implement fair and transparent processes

for decision-making. However, our plans, as well as others around the United States and in other countries, also diverge in ways that may be determined by a host of other factors, from cultural norms on campuses to local and state regulations. Policies such as allowing on-site undergraduate researchers, deciding acceptable occupancy levels in facilities, deciding whether to prioritize certain buildings and activities at the expense of minimal access to everyone, permitting use of nonlaboratory on-site spaces—including libraries, offices, and studios—and allowing field research that does not involve human subjects are among the primary differences in institutional responses. Variations in ramp-down and ramp-up approaches often reflected differing local and state guidelines or mandates, where political and social pressures have the potential to conflict with the best public health recommendations.

Public health frameworks provide a critical and helpful risk-based assessment for when certain industries, governments, and the economy more broadly can reopen [e.g., (9)]. Academic institutions represent a broad set of activities and associated risk where one size (and one policy) does not fit all; however, it is clear from public health expertise that a gradual, stepwise approach to reopening and operating will be essential [see the table; (10)]. Furthermore, the use of metrics both in the community and within institutions will help determine if and when it is suitable to move into the next phase. On-site testing, contact tracing, and determining immunity status will likely play important roles not just in institutional decision-making and risk mitigation but also for broader public health monitoring (11). To do so, institutions will also have to consider how these strategies for research complement strategies being discussed for their broader campus community, as well as weigh potential costs, resources, and privacy concerns. Other metrics that will

help determine when institutions are prepared to move into the next phase include building and laboratory occupancy rates, rates of adherence to physical distancing guidelines, and the number of new cases and symptomatic individuals identified during screening (see the box).

Future ramp-up and stabilization phases should be cautious and flexible enough that research activity can also ramp back down if metrics, public health guidance, or other external factors (e.g., local health care system capacity) dictates. Within institutions, this may also be required for certain laboratories, floors, or buildings if cases are identified and researchers are required to self-quarantine after possibly being exposed to a sick co-worker.

Further control measures will be required for months or more, such as continued physical distancing, engineering controls, requiring personal protective equipment, and administrative controls that include staggering access to spaces through shifts to minimize interactions between personnel (9). Although our suggestions are intended to prioritize caution and reversibility, we are concerned that other ramp-up plans might instead reopen too quickly or without proper safeguards out of a desire to return to prepandemic operations as soon as possible. As we are seeing in countries or other sectors that are prematurely reopening, undesired outcomes such as new transmission and outbreaks could lead to a whiplash effect of being fully open and then back to fully closed. Gradually and carefully resuming on-site research, and demonstrating that mitigations are effective, provides an ideal opportunity for institutions to implement lessons learned to inform the potential arrival of thousands of undergraduate students when terms resume. It will also help inform when other higher-risk activities, such as in-person work with human subjects, can safely resume.

LOOKING AHEAD

Given the length of time that may be required to continue practicing social distancing, it may be years before academic research institutions reach a new normal. Although some beneficial practices may become more routinized (e.g., more alternative work arrangements and virtual meetings), there will undoubtedly be far more deleterious impacts across higher education. Anticipated budget shortfalls from multiple revenue streams suggest that the ongoing pandemic will hamstring institutions financially for years to come. Regarding research specifically, institutions will have fewer internal resources to perform research, invest in research infrastructure, and maintain its workforce. This presents challenges not only for individual institutions but also for the global research enterprise as a whole. In the United States, for example, institutional investments in research comprised ~25% of total higher education R&D spending in 2018 (12), a proportion that has increased considerably over the past decade as the percentage of federal investment in research has declined. For countries in which a large percentage of its research workforce consists of international students, such as Australia, travel and visa restrictions could lead to a substantial loss in revenue to support operations and a considerable reduction of the national scientific workforce (13).

The response to COVID-19 has highlighted how the lack of scenario planning and disaster preparedness is a systemic problem spanning virtually all sectors of society. Despite clear guidance and recommendations based on lessons learned from other disasters (14), the research community has much work to do to improve disaster resiliency. The experience of COVID-19 should make it clear that resilience planning should be a priority going forward, but even the best laid plans fail without effective leadership and coordination. Global coordinating bodies like the World Health Organization, or national agencies, must not be sidelined in their ability to advise governments and guide policies.

In the absence of strong national leadership, most institutions had to quickly develop their own plans for ramping down research, supplemented by ad hoc communication between institutions. Coordinating bodies like the Association of American Universities, which represents 63 major research universities in the United States and Canada, are playing much more prominent roles in facilitating ramp-up and other long-range planning. Improved coordination across academia, government, health systems, and industry during crises will also help identify early roles that institutions could play to address critical needs. For example, institutions could deploy ex-

Should we ramp up?

Checklist for assessing when more research activity is permissible on-site

- Does local or regional public health guidance permit a gradual increase in research activity?
- Do individual labs and the institution have reliable access to supplies such as personal protective equipment and disinfectants?
- Does the institution have the ability to track symptoms, conduct testing, and/or trace and inform contacts?
- Have ramp-up procedures and plans been communicated to researchers?
- Are departments and individual labs ready to work safely?
- Are the support units (facilities, environmental health, security, custodial, transportation) prepared to support more on-site activity?

pertise, resources, or facilities when there is insufficient incentive or capacity for the private or public sectors to refocus production or facilities rapidly, or when they lack capacity to scale up services such as testing. Considering a broader subset of the R&D workforce among essential workers, as in Washington state's "Stay Home, Stay Healthy" order, would help facilitate these cross-sector collaborations more effectively while also maintaining other potential life-saving research unrelated to the pandemic.

Finally, COVID-19 has exacerbated multiple equity issues in the research enterprise that institutions will grapple with in the months and years ahead. This broad-scale disruption of research operations has led to an incalculable number of setbacks for researchers, many of which disproportionately affect early-career researchers and their career advancement. These include the cancellation of long-running experiments, the loss of opportunities to collect critical data (e.g., in field and clinical studies), and lack of access to specialized major instrumentation, among many others. Furthermore, longstanding affordability and child- and family-care disparities across the research workforce—which disproportionately affect women, lower-income support staff, and trainees—are more clear than ever given the sudden and asynchronous sector closures and cost-saving measures implemented at many institutions. Researchers that fall into higher-risk categories on the basis of preexisting health concerns, age, or other immunocompromising conditions face long-term uncertainties around when it is safe to return to work. Systemic solutions such as extensions to promotion and tenure clocks, further deployment of alternative work arrangements, additional fellowship support

for trainees, and policies to allow for extended paid and unpaid leave will be essential to stabilize the research workforce.

Moving forward, it will be up to academic institutions, governments, and funding agencies to develop practices and policies that encourage a more resilient, nimble, and equitable research ecosystem during the COVID-19 pandemic and beyond. Deeper investments in the research workforce and infrastructure will surely help; however, governments should also incentivize stronger ties between public health agencies and academic research institutions to ensure that decision-making at institutions and across communities is guided by the best available research. If not, it is unlikely that the research enterprise or society as a whole will be any better positioned to help generate solutions, or recover itself, when the next disaster arrives. ■

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Moving academic research forward during COVID-19

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Unequal effects of the COVID-19 pandemic on scientists

COVID-19 has not affected all scientists equally. A survey of principal investigators indicates that female scientists, those in the ‘bench sciences’ and, especially, scientists with young children experienced a substantial decline in time devoted to research. This could have important short- and longer-term effects on their careers, which institution leaders and funders need to address carefully.

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The COVID-19 pandemic has undoubtedly disrupted the scientific enterprise. Policymakers and institutional leaders have already begun to respond to mitigate the impacts of the pandemic on researchers. For instance, many universities are making accommodations for their researchers, and the US government has allowed temporary flexibility in grant conditions¹. However, we lack evidence on the nature and magnitude of the disruptions scientists are experiencing.

To gain some insight into the extent of disruptions scientists are experiencing, we conducted a preliminary survey, which was distributed on 13 April 2020, approximately 1 month after the World Health Organization declared COVID-19 a pandemic. We reached out to US- and Europe-based scientists across a wide range of institutions, career stages and demographic backgrounds. Within a week, we received full responses from 4,535 faculty or Principal Investigators (detailed information on our survey is included in Supplementary Methods 1–3). Motivated by prior research on scientific productivity², we solicited information about scientists’ working hours and how their time allocations have changed since the onset of the pandemic. We also asked scientists to report a wide range of individual and family characteristics (for example, field of study, career stage, demographic information, presence of partners or dependents), as these features may moderate the effects of the pandemic^{3,4}.

Varied effects of the pandemic

Overall, we found a decline in total working hours, with the average dropping from 61 h per week pre-pandemic to 54 h at the time of the survey (Fig. 1a). Although only 5% of scientists reported that they worked 42 h or less before the pandemic, this share increased nearly sixfold to 30% during the pandemic. However, the pandemic appears to have

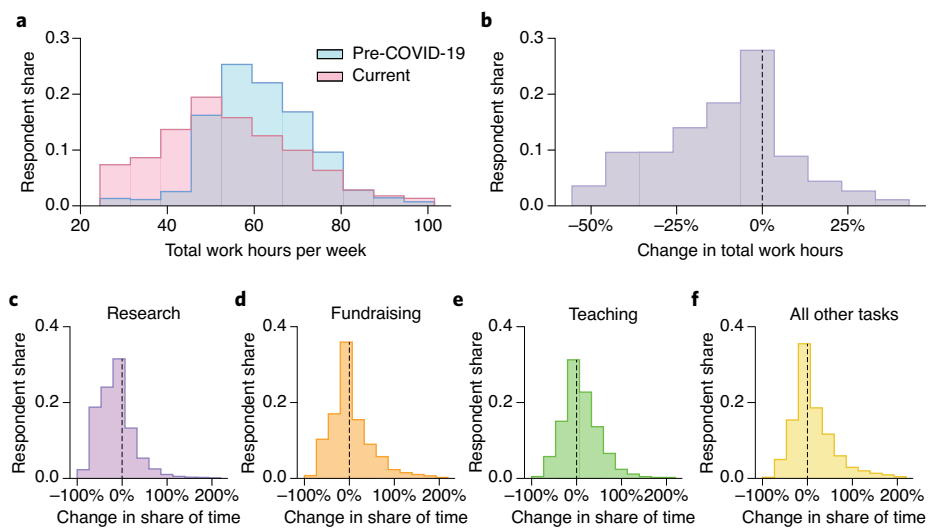


Fig. 1 | Changes in levels and allocations of work time. **a**, Distribution of total hours spent on work pre-pandemic and at the time of the survey. **b**, Distribution of changes in total work hours from pre-pandemic to time of survey. **c–f**, Distribution of percent changes in the share of work time allocated to research (**c**), fundraising (**d**), teaching (**e**) and all other tasks (**f**).

affected scientists in different ways. Although 55% reported a decline in total work hours, 27% reported no change, and 18% reported an increase in time devoted to work.

Scientists perform many different types of work: research (for example, planning experiments, collecting or analyzing data, writing), fundraising (for example, writing grant proposals) and teaching, as well as other tasks (for example, administrative, editorial or clinical duties). Among these different types of work, time devoted to research has changed the most during the pandemic. Whereas total working hours decreased by 11% on average, time devoted to research declined by 24%. In terms of the share of time allocated across the tasks (Fig. 1c–f), research is the only category that saw an overall decline. However, not all researchers reduced the time they devoted to research during the

pandemic: 21% reported spending more time on research and 9% reported no change.

Different fields are affected differently

The pandemic appears to have affected scientists working in different disciplines unevenly (Fig. 2a). Scientists working in fields that tend to rely on physical laboratories and time-sensitive experiments—bench sciences such as biochemistry, biological sciences, chemistry and chemical engineering—reported the largest declines in research time, in the range of 30–40% below pre-pandemic levels. Conversely, fields that are less equipment-intensive—such as mathematics, statistics, computer science and economics—reported the lowest declines in research time. The difference between fields can be as large as fourfold.

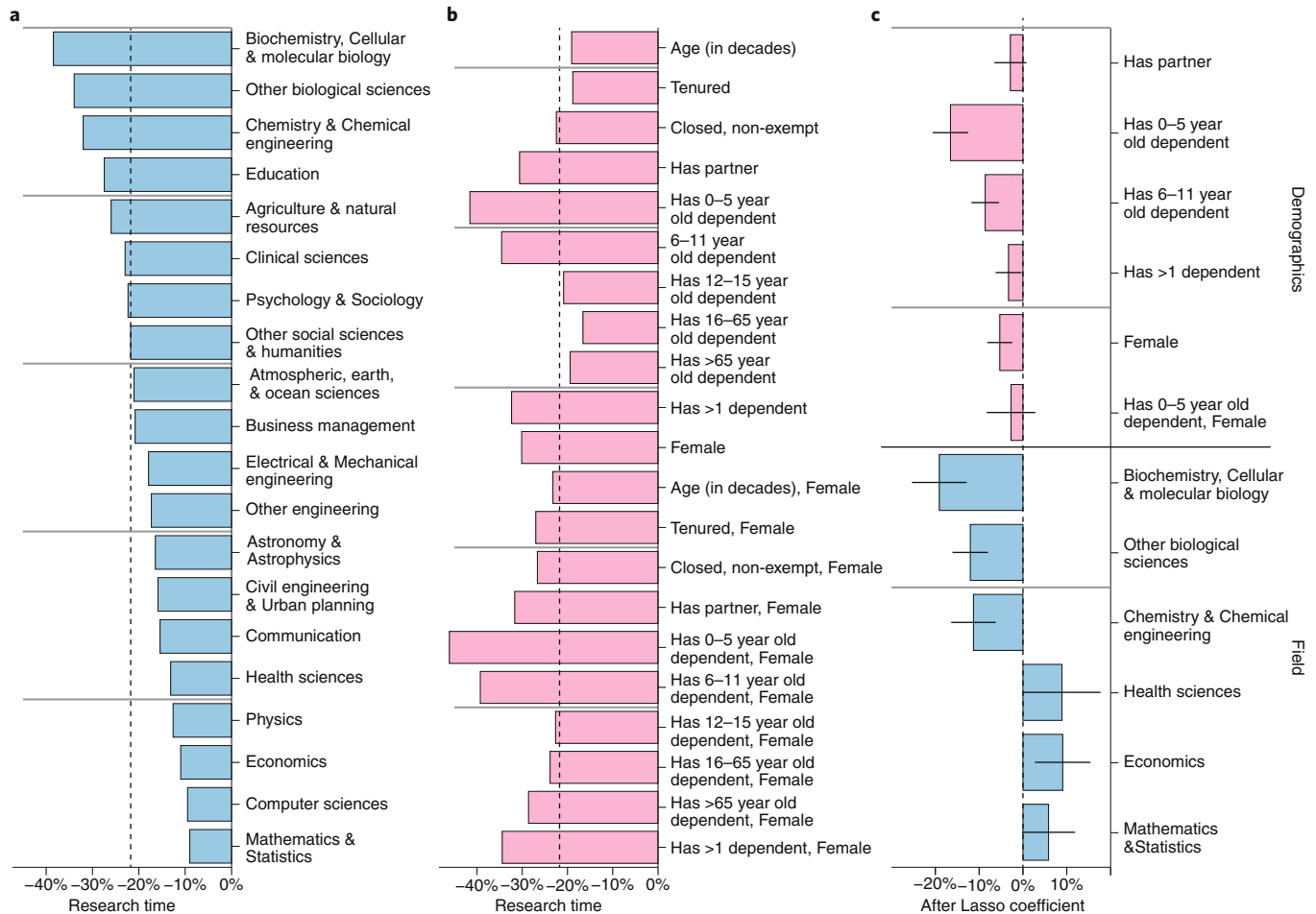


Fig. 2 | Field and group-level changes in research time. **a**, Field-level average changes in research time. **b**, Group-level average changes in research time. **c**, Changes in research time associated with important features of scientists or their fields, after controlling for other factors. To untangle different factors, here we use a Lasso regression approach to select features that are most predictive of declines in research time (see Supplementary Methods 4 for more). Variable names with 'Female' suffix indicate that the variable is interacted with a female indicator; otherwise the variable describes the average change for all scientists. Error bars indicate 95% confidence intervals.

Female scientists and those with young dependents are disproportionately affected

There is a well-documented, persistent gender gap in science^{5,6}. We find that there are indeed substantial differences between our male and female respondents in how the pandemic has affected their work. Female scientists and scientists with young dependents reported that their ability to devote time to their research has been substantially affected, and these effects appear additive: the impact is most pronounced for female scientists with young dependents.

Digging deeper

These field- and individual-level differences may be due to the nature of work common to a field, or they may be due to circumstances unique to individuals (for example, changes

in home life due to school closings, social pressures unique to genders, etc.).

In further analyses (Supplementary Methods 4), we find that, except for the case of the bench sciences, it is the individual circumstances of researchers that can best explain changes in the time devoted to research during the pandemic (Fig. 2). Specifically, although career stage and facility closures seem to play virtually no role in changes to time allocated to research when everything else is held constant, gender and young dependents play a major role. All else being equal, female scientists reported a 5% larger decline in research time. But the most important variable of all appears to be having a young dependent: scientists with at least one child 5 years old or younger experienced a 17% larger decline in research time, all else being equal. Having multiple dependents is associated

with a further 3% reduction in time spent on research, and scientists with children aged 6–11 years were also affected, but to a lesser extent than those with very young children. Our survey results overall indicate that at least some of the gender discrepancy can be attributed to female scientists being more likely to have young children as dependents.

Taking action

Our survey was limited in scale and scope and cannot be used to draw general conclusions. Only 1.6% of the scientists we contacted responded to our survey. Our sample was self-selected and it is likely that scientists who felt strongly about sharing their situation, whether they experienced large positive or negative changes, chose to respond. Our sample mainly applies to US and Europe-based academic researchers. It is also possible that at least some of the gender

differences we found arose due to differences in reporting, rather than differences in outcomes^{7,8}. Nevertheless, comparing our sample with the Survey of Doctoral Recipients⁹ suggests that we oversampled on some of the attributes one might hypothesize to be more relevant to disruptions—namely, female gender and the presence of child dependents (Supplementary Methods 3).

Anecdotal accounts of the impact of the pandemic on scientists have been discussed extensively over the past few months on social media and the popular press. Our survey provides quantitative evidence that highlights disparities in how the pandemic has affected the scientific workforce.

The findings regarding the impact of childcare reveal a specific way in which the pandemic is impacting members of the scientific community differently. Indeed, ‘shelter at home’ is not the same as ‘work from home’ when dependents are also at home and need care. Because childcare is often difficult to observe and rarely considered in institutional research policies (aside from parental leave related to birth or adoption), addressing this issue may be an uncharted—but important—new territory for institutional leaders. Furthermore, it suggests that unless adequate childcare services are available, researchers with young children may continue to be affected regardless of the reopening plans of institutions. And since the need to care for dependents is not unique to the scientific workforce, these results may also be relevant for other labour categories.

Our female respondents reported larger declines in the time they could devote to research than their male colleagues. And scientists with young children appear to have been particularly hard-hit, especially women, who remain primarily responsible for childcare. Understanding the degree to which these changes in time allocations may translate into changes in their scientific output (i.e., funding, publications) will be extremely important to track, especially given that gender is a variable relatively accessible in data-driven studies¹⁰. The pandemic will likely have longer-term impacts that are essential to monitor and address disparities, and further efforts to track the effects of the pandemic on the scientific workforce should clearly take into account household circumstances.

A number of institutions have announced policy responses such as tenure clock extensions for junior faculty. Of 34 US university policies we identified, 30 appeared to guarantee the extension for all faculty (see Supplementary Results 1 for more details). Institutions may favour such uniform policies for several reasons,

such as avoiding legal challenges. But given the heterogeneous effects of COVID-19, these uniform policies that do not consider individual circumstances, while welcoming, may have unintended consequences and could exacerbate pre-existing inequalities¹¹.

While this survey provides a snapshot of the immediate impacts of the pandemic at a single time-point, circumstances will continue to evolve, and there will likely be other notable impacts to science. The disparities we observe may even be exacerbated. For example, as institutions begin the process of reopening, there may be different priorities for bench sciences versus work that involves human subjects or that requires field-work travel, which could lead to new disparities across scientists. The possibility of a resurgence of infections¹² may lead to institutions anticipating a reinstatement of preventative measures and directing their focus toward research projects that can be more easily stopped and restarted. Funders seeking to support high-impact programs may adopt a similar approach, favouring proposals that appear more resilient to uncertain future scenarios. Scientists with potential vulnerabilities to COVID-19 may prolong their social distancing beyond official guidelines. In particular, senior researchers may have incentives to continue avoiding in-person interactions¹³, which historically facilitate mentoring and hands-on training of junior researchers. The impact of such changes on individual scientists and groups of scientists could be substantial, in both the short- and long-term, exacerbating negative impacts among those at a disadvantage. It is therefore important that institutions and funding bodies take into consideration the consequences of policies adopted to respond to the pandemic, as they may disproportionately disadvantage specific groups of scientists and worsen existing disparities.

Lastly, although our respondents were all based either in the US or in Europe, the pandemic is having a substantial impact on research worldwide, which we do not capture. In the coming years, researchers may be less willing or able to pursue positions outside of their home nation, which may deepen or alter global differences in scientific capacity. Future work expanding our understanding of how the pandemic is affecting researchers across different countries, at different institutions, in different points of their lives and careers, and belonging to different demographic groups will be needed to effectively protect and nurture the scientific enterprise. The disparities we observe and the likely surfacing of new impacts in the coming months and years argue for targeted and

nuanced approaches as the world-wide research enterprise rebuilds.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

Because of the sensitive nature of some of the variables collected, the institutional review board (IRB)-approved protocol does not permit individual-level data to be made unrestricted and publicly available. Researchers interested in obtaining restricted, anonymized versions of this individual-level data should contact the authors to inquire about obtaining an IRB-approved institutional data sharing agreement.

Code availability

Code necessary to reproduce all plots and statistical analyses is freely available at https://kellogg-sssi.github.io/covid_survey/. □

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Competing interests

The authors declare no competing interests.

Additional information

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All studies must disclose on these points even when the disclosure is negative.

Study description	A study to quantify the impact of COVID-19 pandemics on scientists.
Research sample	We identified scientists in US and Europe with at least two scientific papers during the past decade. Further details available in Supplementary Information S1.
Sampling strategy	We collected a list of author email addresses from Web of Science. We then randomly shuffled and sampled roughly 280,000 email addresses from U.S.-based authors and 200,000 from Europe-based authors. Further details are available in Supplementary Information S1 and S3.
Data collection	We sent out email invitations with a link to an online survey form. The survey is hosted and collected through the Qualtrics platform.
Timing	The survey was performed in April 2020.
Data exclusions	For our analyses, we focus entirely on responses from the sample of faculty/Principal Investigators, excluding responses from individuals who report to work for a "For-profit firm". We restrict the sample to respondents whose IP address originated from the United States or Europe (dropping 1,049 responses from elsewhere) and drop observations that have missing data for any of the variables used in our analyses. Further details available in Supplementary Information S3.
Non-participation	We estimate a response rate of approximately 1.6%. Further details available in Supplementary Information S3.
Randomization	No randomization.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Included in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input checked="" type="checkbox"/>	<input type="checkbox"/> Animals and other organisms
<input type="checkbox"/>	<input checked="" type="checkbox"/> Human research participants
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern

Methods

n/a	Included in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging

Human research participants

Policy information about [studies involving human research participants](#)

Population characteristics	See above.
Recruitment	We recruit individuals online. Further details on representativeness of our sample available in Supplementary Information S3.
Ethics oversight	The study protocol is approved by IRBs from Harvard and Northwestern.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

The research ecosystem has undergone a complex transformation, necessitating a multifaceted response (opinion)

During the pandemic, the research ecosystem has undergone a complex transformation, which will necessitate a multifaceted response, write Peter Schiffer and Jay Walsh.

[Peter Schiffer](#) and [Jay Walsh](#)

August 5, 2020

In late March of this year, almost every functional aspect of university research changed dramatically across the nation. Conferences were canceled, travel was postponed and most universities were driven into a new mode of remote instruction. Typically, the only personnel on campuses were those with essential duties and those responding directly to the pandemic. Research was [shifted](#) [1] to new modes of operation on a time scale that contrasted sharply with the usual glacial pace of academic change.

Researchers are now cautiously returning to their campuses to re-engage with resources and facilities unavailable in their homes. This restoration of research is a forerunner to the greater reopening in the coming months involving residential instruction at many colleges and universities. In that context, however, all stakeholders must recognize both how broadly and how unevenly the landscape for research has changed.

University researchers are known for their high levels of creativity and resourcefulness, and these strengths have led to a resilient response. Scholars have adapted their work habits toward finishing old manuscripts and proposing new projects. They have made flexible use of resources at hand. Many of them have also directly addressed the crisis itself through development of therapeutics, engineering of PPE and other materials, or research into many facets of the pandemic. And, most importantly, they have paid special attention to the teaching and mentoring needs of students and other trainees.

At the present moment, however, roughly four months from when campuses were largely emptied across the United States, university scholars have vastly different experiences both behind them and ahead of them.

A computational scientist might have been able to continue work from home almost uninterrupted, while a bench scientist might have had lab research totally stopped. The latter now may need to restart experiments from where they were cut off or possibly repeat weeks or even months of preparation.

A scholar who studies live theater or a performing musician who requires an ensemble may still be many months away from continuing their work. By contrast, a researcher who needs library

access to examine manuscripts directly may already have that access restored -- as long as the manuscripts are available in local collections. If the manuscripts happen to be in an undigitized collection on the other side of the globe, separation from that critical resource could stretch much longer. Similarly, the archaeologist, the glaciologist and the ethnographer all may face long disruptions of access to their work and concomitant sidetracking of research plans.

Even researchers in the health sciences, who have been appropriately celebrated for their rapid and often heroic efforts to alleviate the pandemic, will see different vistas depending on whether their specialty is connected to work on COVID-19 or focuses on unrelated topics. Research involving human subjects has been especially impacted, but those researchers also have experienced disparate impacts. While many studies that can be conducted remotely have restarted, or perhaps were never stopped, studies requiring close human contact largely could not proceed as planned and may be postponed indefinitely for subjects who are particularly vulnerable or in an environment that is not amenable to social distancing. Furthermore, some research may be irretrievably damaged. For example, longitudinal behavioral studies may have significant gaps, or perhaps the pandemic has affected subjects in ways that render initial assumptions invalid. In contrast, some researchers have found new directions emerging from the pandemic, encouraged by the opportunity for impact and the newly available grant funding targeted toward shortening and alleviating the virus's damage.

Separate from their research specialties, individual researchers have had widely differentiated experiences over the past four months.

Those who have children at home may have [confronted larger barriers](#) [2] to their productivity than those without them. That impact has been reported to fall [disproportionately on women](#) [3], and it may well continue until schools and daycare centers return to regular operation. Researchers with particular susceptibilities to COVID-19, those with anxiety about health risks and those sharing living spaces with similarly vulnerable people will all face a much more challenging landscape for advancing their work in the coming months -- as will collaborators and trainees who depend on the people who are directly impacted.

Sadly, younger scholars and those who are socioeconomically disadvantaged may be especially harmed by the pandemic in that they may have more limited resources to allow them to work effectively away from their campuses. Coupled with a bleak academic job market, such factors could impede long-term efforts to diversify the academy.

A Shifting Landscape

Aside from individual impacts on researchers and their programs and projects, the broader research landscape has also shifted considerably in the past four months.

International collaboration is now hindered by multiple travel restrictions applied unevenly to citizens of different nations, and to [new impediments to obtaining visas](#) [4]. Simultaneously, federal agencies are increasingly acting on heightened concerns regarding the threat of [foreign interference in research](#) [5]. University researchers have been [indicted](#) [6], agencies have [tightened safeguards](#) [7] and [Congress is proposing new regulations](#) [8]. If adopted, new rules

could significantly redraw assumptions about international cooperation and the open nature of fundamental scientific research.

At the same time, university support has been included in federal relief packages to partially address the financial toll of the pandemic, and more [relief specifically for research](#) [9] is possible. Further, a bipartisan group in Congress has proposed [a vast expansion of the mission of the National Science Foundation](#) [10], with a large multiplier of its budget. All this support is accompanied by a broad recognition of the crucial role that universities have played in pandemic responses and will play in addressing future challenges that the nation will face.

Each of these global shifts by themselves would be considered transformational to university research in a normal time. That they are happening during a global reckoning with the realities of racism, and along with the social upheaval of the pandemic, makes them all the more profound.

As we move into the next phase of the COVID-19 pandemic, we should appreciate the breadth of change across the university research landscape that has happened in such a short time. Rather than a broad and uniform shift, it is a highly heterogeneous shuffling of circumstances that will take months and perhaps years to settle into a new normal. And it will only be made more complex by a possible resurgence of infections or geopolitical changes that are easy to imagine in our near future.

The accompanying challenges to so many university researchers will require action, but the wide variation and the global shifts preclude a one-size-fits-all response. Indeed, a decentralized and nonuniform approach, guided by principles, may be best suited to avoid exacerbating the externally driven heterogeneities. Researchers, along with university leaders, research sponsors and government regulators, must consider the complexity of recent change as they continue to develop the spectacular graduates and produce the transformational discoveries that have made America's universities a model of higher education for the world.

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Source URL: <https://www.insidehighered.com/views/2020/08/05/research-ecosystem-has-undergone-complex-transformation-necessitating-multifaceted>

Links

- [1] <https://science.sciencemag.org/content/368/6496/1190>
- [2] <https://www.nature.com/articles/s41562-020-0921-y>
- [3] <https://www.timeshighereducation.com/news/pandemic-lockdown-holding-back-female-academics-data-show>
- [4] <https://www.the-scientist.com/news-opinion/the-pandemics-effects-on-recruiting-international-stem-trainees-67495>
- [5] <https://www.sciencemag.org/news/2020/06/fifty-four-scientists-have-lost-their-jobs-result-nih-probe-foreign-ties>
- [6] <https://www.politico.com/news/2020/06/09/harvard-china-funding-309766>
- [7] <https://ifap.ed.gov/electronic-announcements/062220ReminderRprtOwnerContrlContrctsGiftsForeignSrc>
- [8] <https://www.aamc.org/advocacy-policy/washington-highlights/senators-introduce-bill-targeting-foreign-government-influence-federally-funded-research>
- [9] <https://www.aip.org/fyi/federal-science-bill-tracker/116th/research-investment-secure-economy-act>
- [10] <https://science.sciencemag.org/content/368/6495/1045.summary>
- [11] <https://www.insidehighered.com/editorial-tags/research>
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