Programmatic Efforts at the National Institutes of Health to Promote and Support the Careers of Women in Biomedical Science

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Abstract

Although women have reached parity at the training level in the biological sciences and medicine, they are still significantly underrepresented in the professoriate and in mid- and senior-level life science positions. Considerable effort has been devoted by individuals and organizations across science sectors to understanding this disparity and to developing interventions in support of women's career development. The National Institutes of Health (NIH) formed the Office of Research on Women's Health (ORWH) in 1990 with the goals of supporting initiatives to improve women's health and providing opportunities and support for the recruitment, retention, reentry, and sustained advancement of women in biomedical careers. Here, the authors review several accomplishments and flagship activities initiated by the NIH and ORWH in support of women's career development during this time. These include programming to support researchers returning to the workforce after a period away (Research Supplements to Promote Reentry into Biomedical and Behavioral Research Careers), career development awards made through the Building Interdisciplinary Research Careers in Women's Health program, and trans-NIH involvement and activities stemming from the NIH Working Group on Women in Biomedical Careers. These innovative programs have contributed to advancement of women by supporting the professional and personal needs of women in science. The authors discuss the unique opportunities that accompany NIH partnerships with the scientific community, and conclude with a summary of the impact of these programs on women in science.

Despite constituting half of the life sciences trainee population since 2004, women remain significantly underrepresented at the faculty level and among senior university administration.[1,2] The NIH Office of Research on Women's Health (ORWH) was established in September 1990 as the first Public Health Service office dedicated specifically to promoting women's health research within and beyond the NIH scientific community.[3] Congress assigned a far-reaching leadership role for the ORWH by mandating that the ORWH director, among initiatives to improve women's health, develop opportunities and support for recruitment, retention, reentry, and advancement of women in biomedical careers. Since 1990, the ORWH, in collaboration with NIH Institute, Center, and Office (ICO) partners, has provided tools and resources to support the career development of the life sciences workforce, including those with NIH-funded grants, researchers who are not currently employed in science, and those considering a career in biomedical research. Here, we review some of the key programs established by the NIH and ORWH to support the career trajectories of women in academic science.

In 1992, the ORWH established the program Research Supplements to Promote Reentry into Biomedical and Behavioral Research Careers, an administrative supplement program that provides research salary support for candidates who have taken a hiatus from their research careers for qualifying circumstances (e.g., family caregiving).[4] The Building Interdisciplinary Research Careers in Women's Health (BIRCWH) program, established in 1999, is a mentored career development program designed to expand the cadre of women's health researchers around the country.[5–8] The NIH Working Group on Women in Biomedical Careers is a committee comprising senior leaders from across the NIH chaired by the director of NIH and the associate director for women's health. The working group and its seven committees have actively worked throughout the NIH to support women in biomedical sciences at all levels of their education and careers.

Research Supplements to Promote Reentry Into Biomedical and Behavioral Research Careers

The pace of scientific discovery, a growing labor market surplus, and increasingly tight funding lines have made it challenging for independent investigators to return to academic science when a period away from work becomes necessary. These dynamics are particularly influential for women, given the timing of fertility with early academic career growth and their increased likelihood of being married to another academic scientist.[9] Following on the heels of a 1992 public hearing and workshop on these topics,[10] the ORWH established a career reentry program to provide supplemental research funding for scientists aiming to return to an independent investigator status after a period away.[4] To date, the

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Research Supplements to Promote Reentry into Biomedical and Behavioral Research Careers program has been supported by 28 of the NIH ICOs.[11] The program operates as an administrative grant supplement to provide financial support for independent research conducted by the reentry candidate, who was in a postdoctoral or faculty position prior to hiatus, in the laboratory of an NIH-funded researcher. The program requires three components: full participation in an independent research project, the opportunity to update and enhance research capabilities through technical skill or professional development, and a carefully planned mentoring program. As of 2014, more than 145 candidates have participated in the reentry program. Although the program is open to both men and women, women are significantly more likely to participate (Table 1).

A telephone survey was conducted by the ORWH in December 2006 to evaluate the success of the program, reaching 98 of the 126 previous reentry candidates. Table 1 presents key findings on the career outcomes of scientists who participated in the survey. The majority of the respondents indicated postprogram involvement in activities associated with research independence. For example, the majority of respondents (83%) published at least one article, with an average of seven articles, in a peer-reviewed journal since receipt of funding. Furthermore, 29% of the women and 33% of the men secured assistant or associate professor positions after reentry. Reentry candidates were also likely to have applied for independent research grants to fund their own research programs.

Participants indicated that the reentry program had increased their scientific expertise, laboratory techniques, grant writing skills, and networking. Qualitative feedback provided by respondents suggested that the program provided ample opportunity for awardees to professionally reengage, and that the experience was marked by both expected and serendipitous moments of professional development by virtue of immersion in laboratory activities. Participants also remarked that the supplement provided a financial incentive for principal investigators to seek out and encourage a return of lost talent to the lab.

Although the majority of reentry participants viewed their experiences favorably, the NIH received valuable feedback from the 10% who indicated that they would be hesitant to recommend the program to a colleague. Feedback from these respondents overwhelmingly focused on mentoring challenges and factors related to a perceived mismatch in fit with a mentor or that of the lab culture and dynamics. To this end, the NIH made clarifications to the role of mentoring in the revision to the administrative supplement in August 2015.[11] Specifically, the research plan must indicate plans to provide opportunities for the candidate's development as a productive researcher, and it also must indicate that the PI is willing to provide appropriate mentorship.[11] A key challenge remains regarding reaching potential candidates and facilitating a match between candidates and active principal investigators. The ORWH and its NIH ICO partners conducted a social media campaign and outreach to university departments and scientific societies in an attempt to reach potential candidates.

Together, these data suggest that the NIH reentry program provides a mechanism for individuals to successfully reenter the biomedical or behavioral research workforce following a qualifying hiatus.

Table 1

Programmatic Information Related to the NIH Research Supplements to Promote Reentry Into Biomedical and Behavioral Research Careers (PA-15-321), at a Glance

Characteristic	Details
Program details	The program provides men and women an opportunity to reenter the biomedical workforce following a hiatus for qualifying circumstances. The program aims to provide mentoring and guidance to these individuals in reestablishing their careers in biomedical, behavioral, clinical, or social science research.
Eligible candidates	Candidates must hold a doctoral degree and have been in a postdoctoral or faculty position at the start of the hiatus. The candidate should have been on hiatus for more than 1 but less than 8 years.
Pilot date	1992
Date of full trans-NIH program	1995
Number of candidates supported	> 145[a]
Gender breakdown	93% women, 7% men[b]
Average hiatus length	5 years[b]
Average length of reentry support	2 years[b]
Percent of candidates reporting career advancement	83[b]
Percent of candidates publishing in peer-reviewed journal	83[b]
Percent of candidates securing a scientific research position	81[b]
Percent of candidates who applied for a grant	60[b]
Percent of candidates awarded a grant (percent awarded an R01)	36 (12)[b]

Abbreviation: NIH indicates National Institutes of Health.
[a]Information was obtained from a 2014 internal analysis.
[b]Information was obtained from a 2006 phone survey. Ninety-six of 126 reentry candidates participated in the survey.

Building Interdisciplinary Research Careers in Women's Health

The ORWH promotes career development for junior scholars by leveraging existing synergies to support women's health in the BIRCWH program. Launched in 1999, BIRCWH is a trans-NIH mentored career development program that seeks to connect junior faculty BIRCWH scholars to senior faculty members with shared interests in women's health or sex differences research.[5–8] Programmatic support for BIRCWH is provided by the ORWH, while grants management resides within

the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD). In addition to the ORWH and NICHD, BIRCWH has been supported by the Agency for Healthcare Research and Quality, nine NIH institutes, and the NIH Office of Dietary Supplements. At the end of 2014, there were 27 active BIRCWH programs across the United States.

Since its inception, the ORWH has invested over $118 million in support of research conducted through the BIRCWH program, funding 77 BIRCWH programs at 39 different institutions. BIRCWH has supported 580 scholars, with 106 involved in the program at the end of 2014. Although BIRCWH was not specifically formed as a program to support the careers of women, they make up the majority of BIRCWH scholars (80%; 464 scholars). BIRCWH scholars also come from diverse educational backgrounds (Figure 1A). Scholars with a PhD received their degrees in a wide range of fields including the life sciences, social sciences, and engineering. Furthermore, scholars with an MD (including MD/PhD) represent 16 medical specialties.

Although initiating an interdisciplinary research program can be difficult because of institutional or departmental silos,[12] such programs are highly beneficial to trainees. Through participating in an interdisciplinary research program, BIRCWH scholars gain an appreciation for the methodology and knowledge of other disciplines.[12] Further, interdisciplinary research provides an opportunity to grow and maintain a professional network,[13] and larger network reach typically leads to more publications and a higher *h*-index.[14] Indeed, there is evidence that participation in the BIRCWH program may be a positive contributor to later professional success, as indicated by the number of BIRCWH scholars receiving subsequent NIH funding. The majority of BIRCWH scholars applied for an NIH career development or research grant 12 months or more after their BIRCWH start date (Figure 1B). Furthermore, BIRCWH scholars experience relative success in receiving grant funding (Figure 1B). Interestingly, women were more likely than men to receive an NIH grant (67% of women compared with 52% of men, Fisher exact test = 0.027), indicating that the BIRCWH program preferentially supports, albeit unintentionally, women's careers. Finally, 82% of completed scholars remain in academic research or teaching positions, with 49% having appointments at the associate or full professor level. Together, these data suggest that the BIRCWH program has been successful in supporting the independent careers of investigators in the women's health workforce.

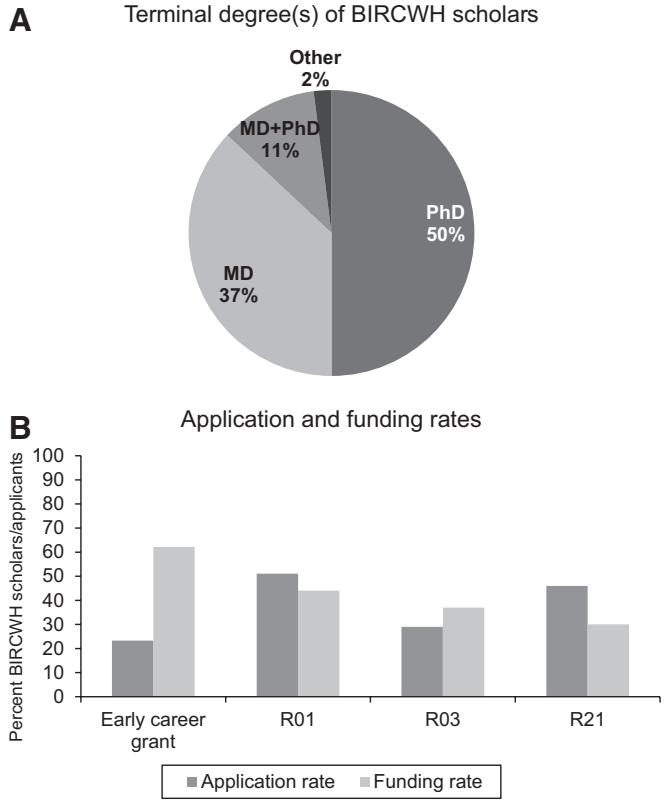

Figure 1 Achievement of BIRCWH scholars. A. Terminal degrees held by BIRCWH scholars are indicated. Other degrees include DrPH, PsyD, and PharmD. B. The application rate (dark gray) and funding rate (light gray) of BIRCWH scholars are indicated for various NIH grants. The funding rate indicates the percentage of applicants. The majority of BIRCWH scholars have submitted at least one NIH grant application more than one year after their BIRCWH start date. Career development grants include K01, K08, K14, K22, K23, K25, K99, and KL1. All BIRCWH data were obtained in October 2014.
Abbreviations: BIRCWH indicates Building Interdisciplinary Research Careers in Women's Health; NIH, National Institutes of Health.

NIH Working Group on Women in Biomedical Careers

In 2007, the National Academies Press published the report "Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering" (BBB), to examine the obstacles faced by women in science and engineering.[2] The report recommended eliminating gender bias in the academy through reforms at multiple levels. In response to BBB, former NIH Director Elias Zerhouni, MD, created the NIH Working Group on Women in Biomedical Careers.[15]

The working group has worked closely with the ORWH, the NIH Office of Extramural Research (OER), the NIH Office of Intramural Research (OIR), and other supporting ICOs on multiple initiatives to enhance the careers of women in science (Table 2). Chaired by current NIH Director Francis Collins, MD, PhD, and Associate Director for Women's Health and ORWH Director Janine Austin Clayton, MD, the working group has expanded over time to include seven subcommittees, each of which address various needs of women within NIH intramural and extramural communities.

Since its inception, the working group has hosted workshops, conferences, and presentations to address the needs of

Table 2

Key Accomplishments of the NIH Working Group on Women in Biomedical Careers and Its Subcommittees, 2007–2015

Committee	Year	Accomplishment
Working Group	2007	Workshop: National Leadership Workshop on Mentoring Women in Biomedical Careers[a]
	2007–2014	Bimonthly publication: NIH Updates on Women in Science newsletter[a]
	2008	Conference: Women in Biomedical Research: Best Practices for Sustaining Career Success[a]
	2008	Publication: Women in Science at the National Institutes of Health 2007–2008[a]
	2012	Expanded the NIH reentry supplement program to include postdoctoral researchers[a]
	2013	Hosted presentation: "Promoting Career Success for Underrepresented Groups in STEMM: Challenges and Lessons Learned from a Diverse Scholar" by Alberto I. Roca, PhD
	2015	Bimonthly publication: ADVANCES & INSIGHTS: The NIH Women in Science Newsletter[a]
Extramural Activities and Mentoring Programs	2008	Doubled the allowed period of parental leave for Ruth L. Kirschstein National Research Service Award trainees[b]
	2010	Requirement for applicants of conference grants to describe plans to identify family care resources[b]
	2011	Published: Web site detailing family-friendly policies[b]
	2011	Expanded biosketch to allow applicants to describe factors that may have affected scientific advancement or productivity[b]
NIH Intramural Research Program	2008	Developed family-friendly policies including extended parental leave for NIH trainees, extended tenure clock to account for family leave, established a temporary lab manager program for NIH investigators on extended leave, and established the NIH Back Up Care program for child and elder care[c]
	2012	Establishment of Keep the Thread, an accommodation program available to all Intramural Research Training Award postdoctoral fellows[c]
	2013	Analyzed the equity of salaries in the NIH Intramural Research Program[c]
	2014	Establishment of the NIH Voluntary Leave Bank[c]
	2014–2015	Held focus groups with NIH postdoctoral fellows about career aspirations[a,c]
Research and Evidence to Promote Women in Biomedical Careers	2008	Published: RFA-GM-09-012 to support research on causal factors and interventions that affect the careers of women in biomedical and behavioral science and engineering; fourteen grants were funded[d]
	2012	Workshop: Causal Factors and Interventions Affecting Careers of Women in Biomedical and Behavioral Science and Engineering[a,d]
	2012	Formation of the Research Partnership on Women in Biomedical Careers, a grassroots group of the awardees of RFA-GM-09-012[a,d]
	2014	Workshop: Advancement of Women in Biomedical Careers[a,d]
Women of Color in Biomedical Careers	2012	Development of the Women of Color Research Network[e]
	2013	Hosted presentation: "Promoting the Participation of Women in Japanese Science" by Dr. Sanae M.M. Iguchi-Ariga[e]
	2014	Hosted a symposium, "The Health of Women of Color: A Critical Intersection at the Corner of Sex/Gender and Race/Ethnicity," at the NIH Research Festival[a,e]
	2014	Development of the Spectrum Blog[e]
	2014	Recipient of the National Institute on Aging Health Improvement Institute's Aesculapius Award of Excellence for the Women of Color Research Network
	2014–2015	Formation of four local chapters of the Women of Color Research Network[e,f]
	2014–2015	Targeted effort to nominate women of color for awards to increase recognition[a]
	2015	Recipient of an NIH Office of the Director Honor Award for the Women of Color Research Network
Communication and Public Outreach	2014	Launch of the Working Group Web site: www.womeninscience.nih.gov[g]

Abbreviation: NIH indicates National Institutes of Health.
[a]In collaboration with the NIH Office of Research on Women's Health.
[b]In collaboration with the NIH Office of Extramural Research.
[c]In collaboration with the NIH Office of Intramural Research.
[d]In collaboration with the National Institute of General Medical Sciences.
[e]In collaboration with National Institute on Aging.
[f]In collaboration with the Office of Equity Diversity and Inclusion.
[g]In collaboration with the National Institute of Environmental Health Sciences.

women in the biomedical sciences.[16,17] With leadership from the ORWH, the working group publishes ADVANCES & INSIGHTS, a bimonthly newsletter that includes summaries of studies and reports pertaining to women in science, profiles and personal insights of successful women in science, and highlights of innovative initiatives at institutions and organizations that support women in scientific careers.[18] The newsletter currently reaches over 1,000 subscribers. The group also maintains an active Web site.[15] In 2014, the National Institute of Environmental Health

Sciences provided substantial support to the Working Group Committee on Communications and Public Outreach to redesign the site, which provides news and resources for women pursuing academic careers.

The NIH OER and the Working Group Committee on Extramural Activities and Mentoring Programs have implemented many programs to address issues related to work–life integration. Examples include doubling the amount of parental leave for Ruth L. Kirschstein National Research Service Award (NRSA) trainees and requiring that applications for NIH conference grants describe plans to identify family care resources.[19] Furthermore, the OER extended the eligibility requirements of Early Career Investigator status to accommodate applicants who have experienced a lapse in research or research training.[20] The NIH also supports time off for funded researchers to care for a family member or in the event of a personal disability. Most NIH grant awards now allow for reimbursement of actual, allowable costs incurred for child care, parental leave, or additional technical support, as long as costs meet certain requirements.[19] Finally, the NIH offers an opportunity for prospective grantees to provide details in their grant applications about personal circumstances—such as time off for family caregiving, illness, or military service—that may have affected their scientific advancement or productivity.[21]

The NIH OIR and the Working Group Committee on the NIH Intramural Research Program have instituted family-friendly policies that support the career development of NIH intramural investigators and trainees. The "Keep the Thread" program allows NIH postdoctoral fellows to make adjustments to their daily work arrangement in times of intense caregiving to maintain their connection to the scientific community.[22] The OIR has also implemented an "Extend the Clock" provision that allows NIH tenure-track investigators to delay a tenure decision as a result of time taken for family care.[23]

The working group is also addressing the challenges faced by women from diverse backgrounds in navigating successful scientific careers. The Working Group Committee on Women of Color in Biomedical Careers, which receives significant support from the National Institute on Aging and ORWH, has established the Women of Color Research Network (WoCRN),[24] an award-winning Web site that provides a forum for scientists to connect with mentors and role models, learn about the NIH grants process, and find career development advice. The Web site offers a platform for scientists to explore opportunities and share experiences through discussion boards and connections with colleagues. The network is open to all who value diversity in the scientific workforce. Moreover, the committee systematically nominates women for awards and prominent lectureships to increase recognition of women scientists of color.

The Working Group Committee on Research and Evidence to Promote Women in Biomedical Careers focuses on expanding support for research on women in science and improving the efficacy of organizational programs designed to reduce gender bias and bring about systemic organizational change. In 2008, with substantial support from the National Institute of General Medical Sciences, the committee issued a trans-NIH request for applications for "Research on Causal Factors and Interventions That Promote and Support the Careers of Women in Biomedical and Behavioral Science and Engineering (CFI)."[25] The desired outcome of the proposed research was a better understanding of the factors influencing underrepresentation of women in science, identification of new principles that would inform the development and adaptation of new and existing interventions, and analyses of the differences in career activities of men and women in biomedicine.[25] The trans-NIH request for applications was supported by 18 NIH ICOs, which contributed approximately $16.5 million to the support of 14 four-year grants with 24 investigators. The ensuing research focused on five of the seven recommendations made by the BBB, parsed into broad categories (Figure 2A). The funded research primarily focused on women at the faculty level, but studies were also conducted on other groups (Figure 2B; Table 3).

A November 2012 NIH workshop served as a forum for CFI grantees to present data from their research and to discuss results and their implications.[16] In June 2014, the working group assembled a collection of deans and other high-level administrators at medical and graduate schools to develop potential intervention strategies. A final report describes four general areas in need of institutional support, and all within the purview of academia: support for leadership; changes to academic culture; psychological and social influences; and training and education.[17]

At the previously mentioned 2012 workshop,[16] the CFI investigators decided to continue communication and collaboration amongst themselves. They formed the Research Partnership on Women in Biomedical Careers, a grassroots group aimed at continuing the research goals brought forth through this program. The grantees, 22 out of 24 of whom are women, have been highly productive. Between receipt of CFI funding and May 2015, the group has written 62 publications and given 162 presentations on women in science, demonstrating widespread dissemination of research focused on the impediments to reaching gender parity in science and interventions to increase representation of women (Figure 2C). They have also received 24 additional grants and 31 nonfinancial accolades. The publications constituting this collection in *Academic Medicine*, and the existence of the collection itself, are the result of the dedication of the research partnership.[26–32] The ORWH continues to provide administrative and strategic support to the group in recognition of the importance of continued research and collaboration among these investigators.

Summary of Accomplishments

Here, we have summarized key programs to support biomedical careers initiated by the NIH, including the ORWH. From providing support for career reentry to mentored career development programs, the NIH has bolstered and continues to enhance programs that support career development opportunities for women and men in the life sciences. Although the programs highlighted here are specific to the NIH and the NIH-funded workforce, the effects of these programs can be felt in institutions and departments funded by other federal agencies or within the private sector.

Since the establishment of the ORWH, there has been significant progress in recruitment, retention,

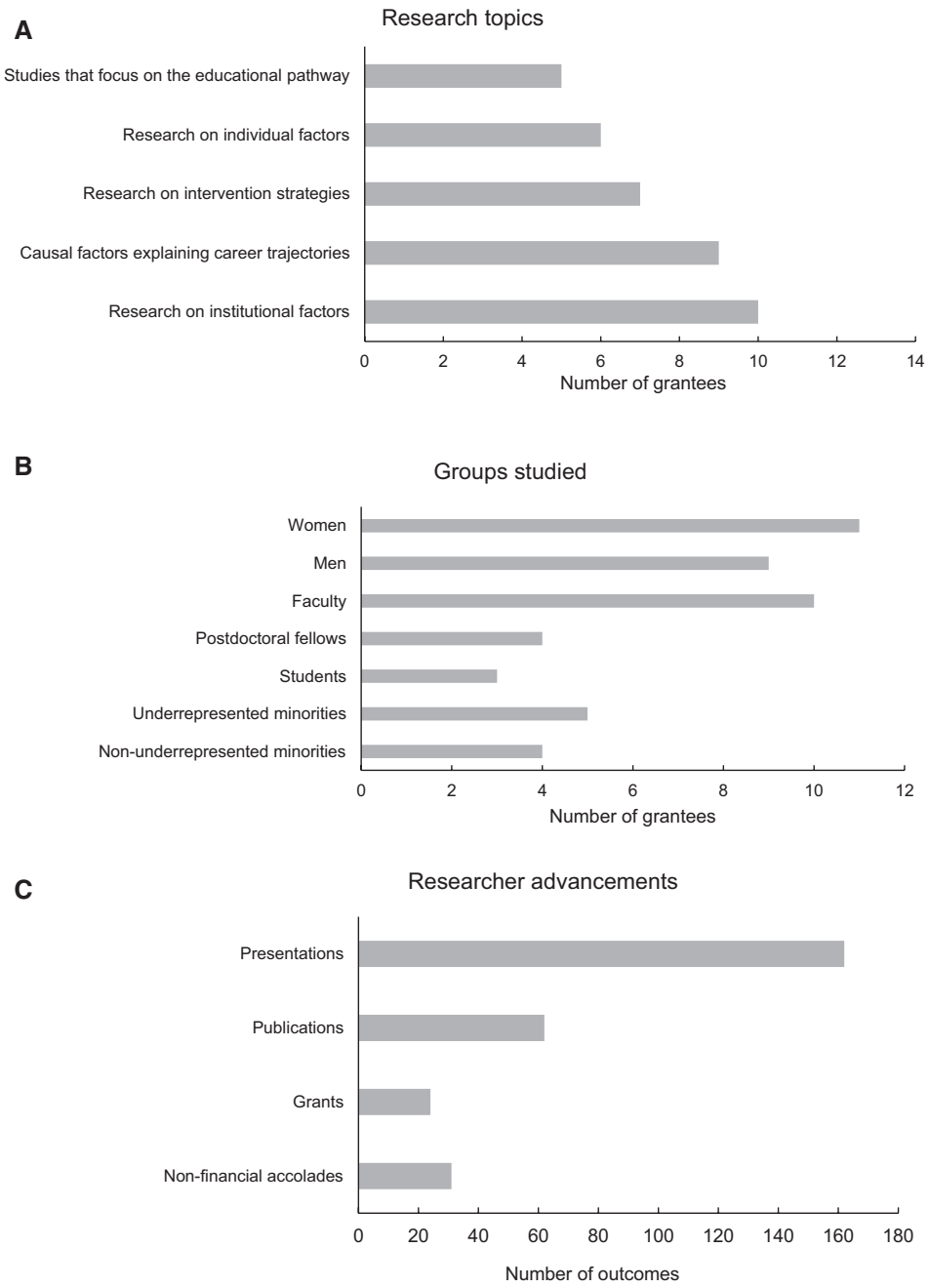

Figure 2 Achievements of the Research Partnership on Women in Biomedical Careers. A. The announcement for CFI grants listed key research topics to be studied. Investigators from the 14 groups funded through this program were asked to categorize their research. Institutional factors were most commonly studied (topics are not mutually exclusive). B. The populations of individuals studied by each of the grantees are indicated. Women at the faculty level were the most frequently investigated. C. As of May 31, 2015, the investigators funded through the CFI announcement have given 162 presentations and published 62 manuscripts on women in the biomedical workforce. Additionally, the grantees have been awarded 24 additional grants and 31 nonfinancial accolades.
Abbreviation: CFI indicates Causal Factors and Interventions.

and advancement of women in the life and health sciences. The percentage of doctorates earned by women in the life sciences has increased from 30% in 1986 to 48% in 2006.[33] Similarly, the number of MD degrees awarded to women has steadily increased from 36% in 1989 to 48% in 2011.[2,10] Furthermore, although women remain underrepresented among university faculty, representation at all ranks has continued to increase. Most notably, women now constitute 19% of full professors compared with 9% in 1989.[1,10] Finally, in 1983, women with doctorates in the life sciences were 2.83 times more likely to be unemployed than men with doctoral degrees in the life sciences.[34] Today, there is no significant difference in the overall unemployment rate between these groups.[1] Although much work remains, these achievements illustrate significant progress toward parity within the life and medical sciences. This progress has been undoubtedly aided by the innovative programs implemented by the NIH and ORWH.

Table 3

Beyond Bias and Barriers[2] Recommendations Addressed by Researchers Funded Through RFA-GM-09-012, and Academic Institution Where Research Was Performed

Recommendation	Institution(s) where research was performed
R1. Trustees, university presidents, and provosts should implement changes in institutional culture.	Northwestern University
	University of Michigan
	University of Pennsylvania
	University of Wisconsin
	University of New Mexico
	University of Oklahoma
	Boston University and Massachusetts General Hospital
	University of California, Davis
	Cornell University and University of Texas, Austin
R2. Deans, department chairs, and their tenured faculty should develop programs to minimize biases.	Harvard Medical School
	Hunter College, Rice University, and University of Texas–MD Anderson
	University of Kansas and Boston University
	Cornell University
	University of California, Davis
	Cornell University and University of Texas, Austin
	University of Pennsylvania
	Northwestern University
	Boston University and Massachusetts General Hospital
	University of Oklahoma
R3. University leaders should ensure fair evaluation practices.	Hunter College, Rice University, and University of Texas–MD Anderson
	University of New Mexico
	Cornell University and University of Texas, Austin
R4. Professional societies and higher education organizations (including universities, scientific and professional societies, honorary societies, and journals) are responsible for promoting equal treatment of women.	Columbia University
	Harvard Medical School
	Northwestern University
	University of New Mexico
R5. To ensure the full participation of women, federal funding agencies and foundations should provide opportunities to reduce gender bias through workshops, collecting demographics, family-friendly policies, establishing funding mechanisms, funding research on reducing gender bias.	University of New Mexico
	University of Kansas and Boston University
	Northwestern University
	Cornell University
	University of California, Davis
R6. Federal agencies should establish and enforce guidelines to reduce gender bias.	Not addressed
R7. Congress should implement policies to encourage enforcement of antidiscrimination laws.	Not addressed

Women have greatly benefited when institutions have undertaken efforts to improve the culture. For example, a 1999 report from the Massachusetts Institute of Technology (MIT) indicated three issues of concern: women were underrepresented in the faculty ranks, women felt marginalized, and it was difficult to combine work and family responsibilities.[35] The deans of the Schools of Science and Engineering responded to the report by instituting policies to change practices at MIT. As a result, at that institution there has been an increased number of women faculty, a more equitable resource and salary distribution, and increased representation of women in senior administrative positions.[36] Similarly, the Carnegie Mellon School of Computer Science made changes to the curriculum, pedagogy, and culture of its program, resulting in a significant increase in the number of women in the undergraduate computer science programs.[37] Both programs highlighted here indicate that a change in institutional culture can result in tangible effects for women students and faculty, suggesting that future work in this area will be necessary for sustained advancement of women in the biomedical workforce. The inception of the ORWH and intra- and extramural programs at the NIH also represent an institutional shift that has served as an example for other institutions and has improved the overall cultural landscape for women scientists since 1990.

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