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Detailed Findings from RTI's Study of L'Oréal USA's For Women in Science Program



Final Report

Prepared by
Christine Lindquist, PhD
Tasseli McKay, MPH
Amanda Witwer, BA

RTI International
3040 E. Cornwallis Road
Research Triangle Park, NC 27709

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FOR WOMEN IN SCIENCE
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Executive Summary

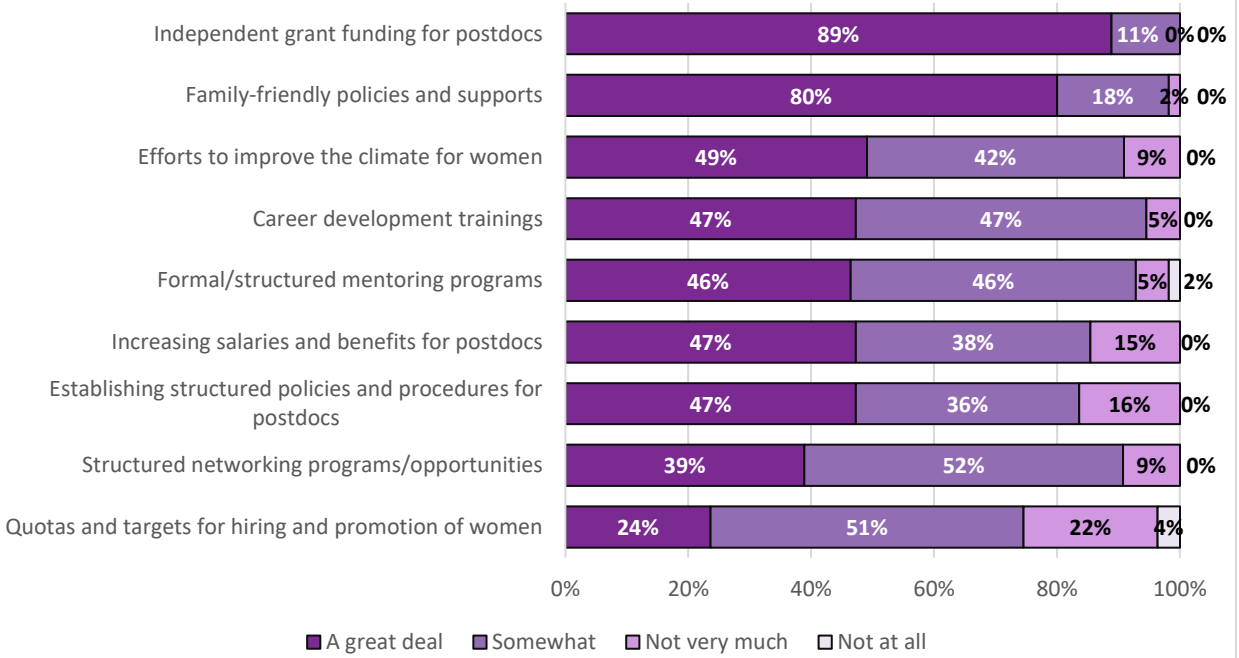
Background. To further the national dialogue around the underrepresentation of women in STEM and contribute to policy and programmatic solutions aiming to address this gap, L'Oréal USA and the Heising-Simons Foundation contracted with RTI International to conduct a study of the For Women in Science (FWIS) fellowship program. Web surveys were completed by 63 of the 75 fellows who have been funded since 2003 and in-depth interviews were conducted with a subset. The study identified lessons from FWIS fellows—all of whom have remained working in science, been exceptionally prolific in their scientific achievements, and are actively involved in mentoring the next generation of scientists—on promising strategies to improve the retention of women during and after their postdoctoral training.

Key Findings. When reflecting on their own experiences during postdoctoral training, it was clear that obtaining independent grant funding at this stage of their careers, which included the FWIS fellowship, was the most impactful facilitator of success for fellows. Fellows identified a number of lasting professional (and personal) benefits from having received independent funding, which centered around their ability to pursue innovative and high-risk, high-reward research topics distinct from their primary mentors' and establish their own lines of research early in their careers. Other major facilitators that helped mitigate some of the challenges encountered during postdoctoral training were support from fellows' family and friends, as well as peers and colleagues.

Fellows had mixed outlooks on the current state of women in science—recognizing that many gains had been made in the past decade for women in science, particularly in regard to gender composition and women's representation in leadership positions, while also identifying the persistent role of gender discrimination, lack of equal opportunities for women in their fields, and climate in many scientific fields that is unsupportive of parents in a number of ways. The most significant challenges that fellows felt continued to threaten women's career trajectories during the postdoctoral training phase were self-doubt or lack of confidence (which was also the most impactful challenge for fellows personally), family constraints or responsibilities, and difficulty obtaining external funding. Fellows' top recommendations for the specific supports or interventions they felt would be most effective in promoting women's career advancement in the postdoctoral stage were independent grant funding for postdocs and family-friendly policies and supports (see Exhibit ES-1).

Implications for Policy. The findings of this study highlight the need for, and value of, independent funding for women scientists at the postdoctoral stage. Universities, private corporations, professional associations, foundations, and federal funding agencies should seek to develop more mechanisms that provide independent funding to women postdoctoral scientists. The current funding opportunities for postdoctoral trainees are extremely limited, and study findings suggest that investments during the postdoctoral training stage could have large impacts for the retention of women in science. In addition, echoing recommendations made in a number of other studies, this study indicates the need for structured family supports and family-friendly policies specifically targeted to postdoctoral trainees. Not only are specific interventions needed, particularly paid family leave and affordable, high-quality childcare, but efforts to make the culture within labs and departments more family-friendly could allow more women to feel that it is possible to be a mother and have a successful career in science, as opposed to choosing one or the other. Several other implications are suggested by study findings, including the need for improvements in mentoring and networking opportunities available for women, and strategies to address the confidence gap among women in science.

Exhibit ES-1. To what extent is each support/intervention effective in promoting women's career advancement in the postdoctoral stage? (% of fellows)



Introduction

Background

To coincide with the 15th anniversary of L'Oréal USA's For Women in Science (FWIS) fellowship program, L'Oréal USA and the Heising-Simons Foundation contracted with RTI International to conduct a study of the program's fellows. The study examined factors critical to the fellows' success in order to further the national dialogue around the underrepresentation of women in STEM and contribute to policy and programmatic solutions aiming to address this gap.

The study focused heavily on solutions relevant to the postdoctoral training stage (a temporary stage of mentored research and advanced training that follows a doctoral degree), which is a career transition point associated with significant attrition among women in STEM fields.¹ The U.S. FWIS program was designed to support women scientists during this critical career stage. The fellowship provides financial support for women postdocs in the life, physical/material sciences, engineering, technology, computer science and/or mathematics fields. Each fellow receives a \$60,000 grant that can be used in a number of ways, including the fellow's salary, travel, equipment, supplies, or hiring of trainees. In addition to the financial component, fellows receive media and communications training, exposure to science policymakers and other networking opportunities, earned media coverage and public recognition through L'Oréal USA.^{2,3}

Each year, a cohort of five fellows is selected through a highly competitive selection process managed in partnership with the American Association for the Advancement of Science (AAAS). To date, 75 fellowships have been awarded since the inception of the program in 2003.

Methodological Approach

An independent, non-profit research organization, RTI International, conducted a rigorous mixed-method study to document the experiences of the FWIS fellows and develop a comprehensive understanding of the challenges and opportunities for intervention during the postdoctoral training stage. The study included two components: 1) a web-based survey administered to all 75 fellows, and 2) in-depth qualitative interviews with a subset of 10 fellows.

The web-based survey included closed- and open-ended questions about fellows' current careers, perceptions of the FWIS program, experiences during postdoctoral training, scientific accomplishments, and outlook on women in science.⁴ The survey was voluntary and administered in a confidential manner. (Fellows were assigned a study identification number, which they used to log in to the survey, and all

¹ National Postdoctoral Association (2011). Postdoctoral Scholars, Gender, and the Academic Career Pipeline A fact sheet <https://cdn.ymaws.com/www.nationalpostdoc.org/resource/resmgr/Docs/postdoc-gender-fact-sheet-20.pdf>

² For more information about the FWIS program, see <https://www.lorealusa.com/csr-commitments/l%E2%80%99or%C3%A9al-usa-for-women-in-science-program>

³ FWIS fellows must also commit to at least twenty hours of activity in support of women and girls in science (e.g., mentoring, classroom visits, media, events).

⁴ When developing the survey, wherever possible, survey questions/response options were taken (or adapted) from existing national surveys, including the Early Career Doctorates Study (2015, 2017), the 2016 National Postdoctoral Survey, the National Postdoctoral Association Study on Influences on the Career Transitions of Female Postdoctoral Scholars, and the Sigma Xi Postdoc Survey. The L'Oréal Foundation Alumnae Survey guides were also reviewed by RTI.

responses are presented in a deidentified manner with the exception of select open-ended responses for which fellows were given the option of having these responses attributed to them.) The survey was fielded from 6/20/19 through 7/14/19, with follow-up reminders e-mailed to nonrespondents. Sixty-three fellows (84%) took the survey, with an average completion time of 35 minutes. Descriptive analysis of web survey responses was conducted in SAS Enterprise Guide, Version 7.15.⁵

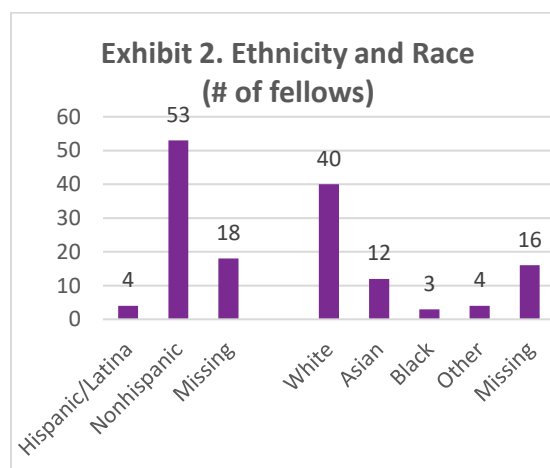
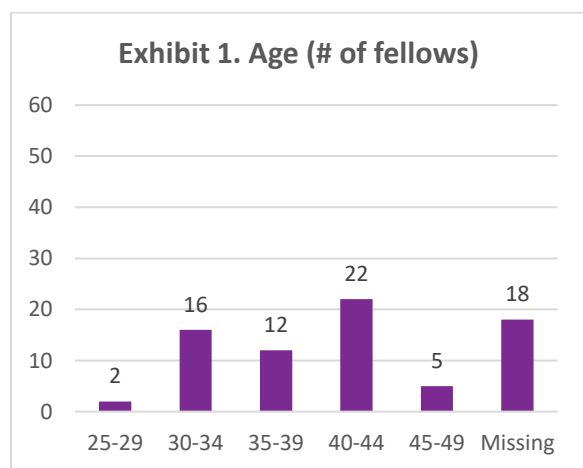
The qualitative interviews were designed to provide additional depth to the web survey data by highlighting select fellows’ experiences with the FWIS fellowship, ideas for interventions that could help support other women during their postdoctoral training, and significant career accomplishments. Ten fellows were selected for this component based on a combination of their web survey responses (particularly policy-relevant insights, career accomplishments, and the benefits of the FWIS program for them) and with an eye for diversity in terms of career stage, field of study, and demographic characteristics. The qualitative interviews were conducted over the phone by RTI researchers from 7/25/19 to 8/6/19, following a semi-structured interview guide. The interviews took approximately 30 minutes and were audio-recorded and transcribed for analysis. Resulting textual data were sorted by domain and reviewed to identify inductive themes and supporting quotations.

The remainder of this report presents detailed findings obtained from both the web survey and qualitative interviews.

About the FWIS Fellows

Background Characteristics

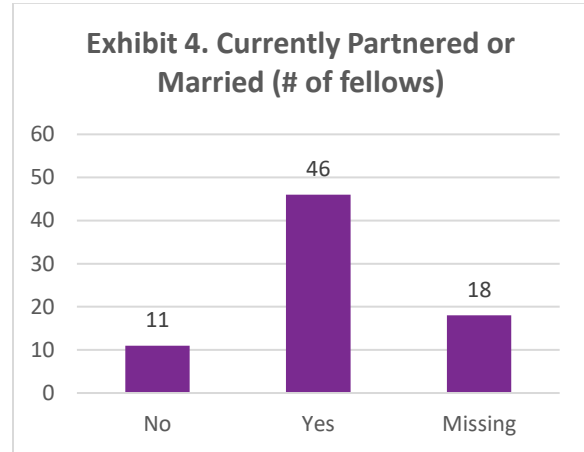
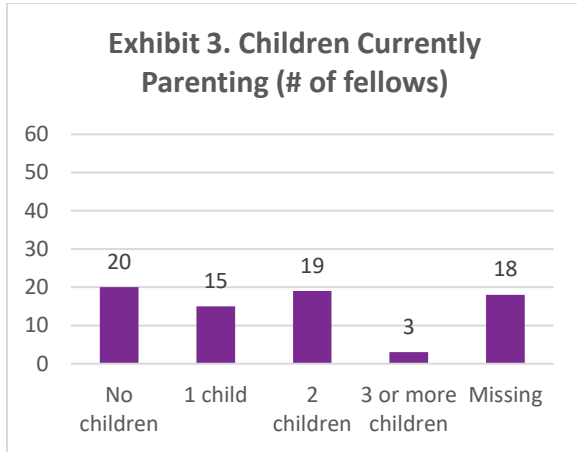
Fellows’ age ranges and race/ethnicity are shown in Exhibits 1 and 2, respectively. Just under a third of fellows are currently between the ages of 40-44 and the majority are non-Hispanic white. Fourteen fellows were born outside of the United States and nine fellows indicated that none of their parents or guardians had obtained a college degree (data not shown).



Family status is shown in Exhibits 3 and 4. From among the fellows who responded to this question, about two thirds (65%) indicated that they were currently mothers to at least one child. When asked about their parental status during their postdoctoral training (data not shown), 15 fellows (41% of those

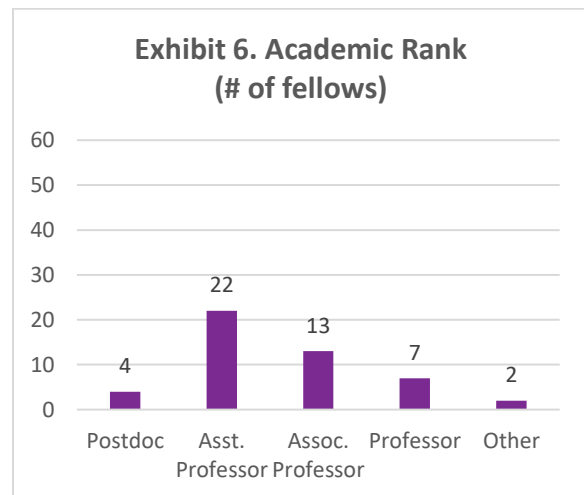
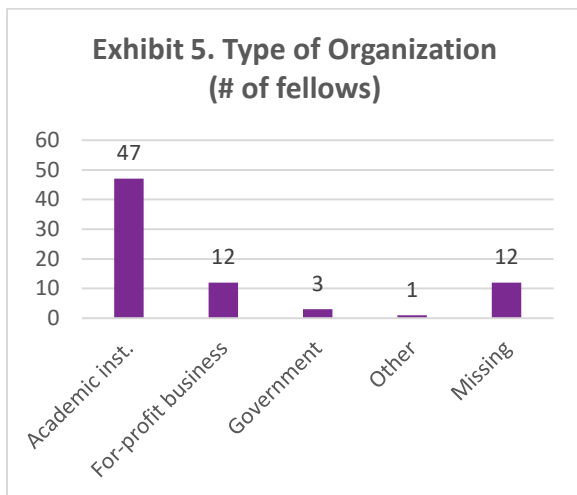
⁵ Copyright © 2017 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

who provided data) were mothers to at least one child (with four fellows parenting two or more children during this stage of their career). The majority of fellows who responded to this question (81%) described their current relationship situation as “partnered or married”. Similarly, 72% of fellows indicated they were partnered or married during their postdoctoral training (data not shown).



Current Careers

From among the fellows who participated in the survey, 100% indicated that they were currently working in a paid, science-related position. As shown in Exhibit 5, the majority of fellows (75% of those who responded to this question) are currently working in an academic institution. Among these fellows, the most common rank is assistant professor, followed by associate professor, professor, or postdoctoral fellow (hereafter “postdoc”) (Exhibit 6). The “other” category includes both academic specialists and administrators, including deans, department chairs, or directors.



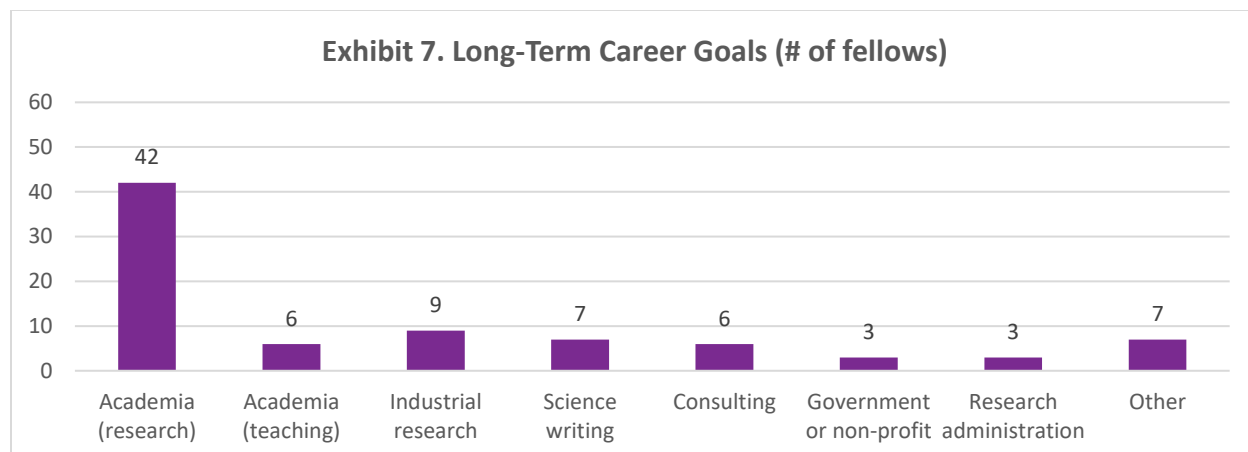
Among fellows working outside of academia, the most common roles within their organizations are managers or directors (n=7); individual contributors (n=6); or founders, cofounders, CEOs, or C-Suite executives (n= 2). Overall, 47 fellows (75% of those who responded to this question) indicated that they currently have a management, supervisory, or leadership role at their institutions or organizations. Specifically, fellows serve as Directors or Associate Director of centers or departments, committee chairs

(for university and/or professional association committees), principal investigators (PI), as well as managing labs and supervising students and staff.

Fellows' current primary fields of study include: engineering (n=11), neuroscience (n=9), microbiology, immunology, or virology (n=6), physics (n=6), chemistry (n=4), ecology or environmental science (n=3), materials research (n=3), astronomy and planetary sciences (n=2), biochemistry (n=2), biology (cell, molecular, developmental) (n=2), biology (not cell, molecular, developmental) (n=2), genetics (n=2), oceanography/marine science (n=2), pharmaceuticals (n=2), anthropology (n=1), computer sciences (n=1), geosciences (n=1), bioinformatics (n=1), biotechnology/synthetic biology (n=1), and astrobiology (n=1).

Long-term Career Plans and Motivators

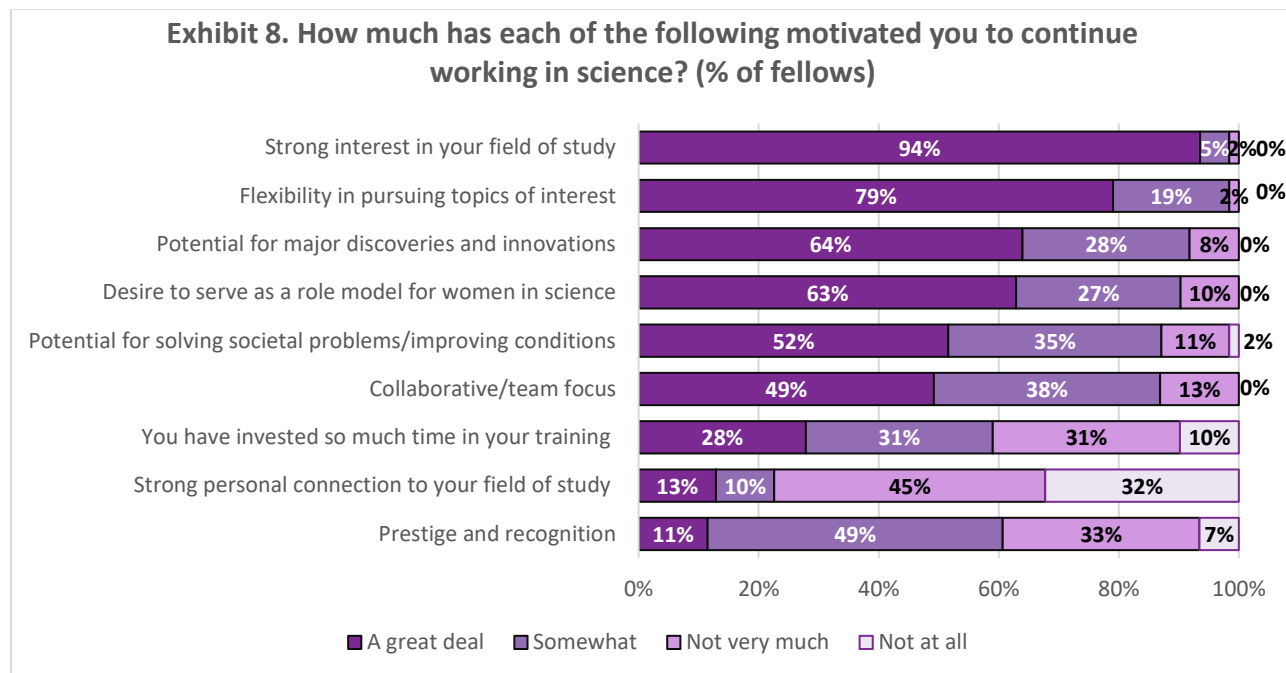
When asked about their long-term career plans (operationalized as plans over the next ten years), 100% of fellows indicated that they intend to continue working in a paid, science-related position. Fellows' long-term career goals are shown in Exhibit 7.⁶ The most common career goal was a research-based position in academia, followed by industrial research, science writing, a teaching-based position in academia, consulting, research administration, or a position in a government or nonprofit organization. Other career goals included patent law technology transfer, science policy, founding start-ups, medical affairs, open science advocacy, and conservation work.



The extent to which various factors have motivated fellows to continue working in science is shown in Exhibit 8, with the factors ordered by their importance to fellows. The most influential motivators were a strong interest in their field of study (which 94% of fellows said motivated them “a great deal”), the flexibility to pursue topics of interest (which motivated 79% of fellows a great deal), the potential for major discoveries and innovations (which motivated 64% of fellows a great deal), and their desire to serve as role models and create opportunities for other women and girls in science (which motivated 63% of fellows a great deal). Less influential factors were prestige and recognition, having invested so much time in their training, and having a strong personal connection to their field of study. Among women who indicated that they were motivated by a strong personal connection to their field of study (i.e., that they or their family are directly impacted by their research), some noted that their research focused on health conditions experienced by family members, including eating disorders, diabetes, and

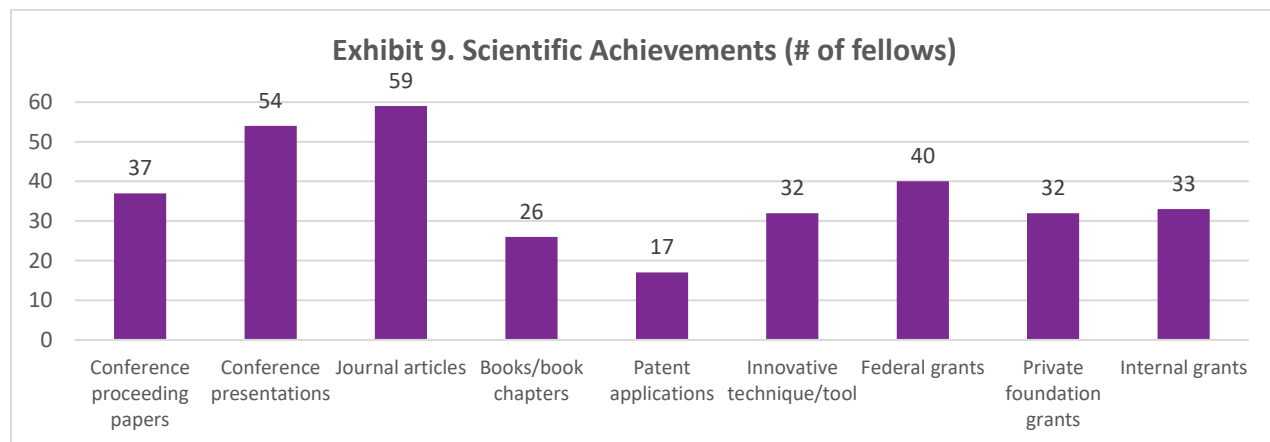
⁶ Fellows could select more than one response to the survey question regarding their long-term career goals.

Parkinson’s disease. Some fellows felt that their areas of research impacted everyone personally (e.g., climate change). A few fellows volunteered other motivators through an open-ended response, including the desire to mentor and train students (n=4) and the flexible work schedule available to them (n=2).



Scientific Achievements

Fellows’ scientific achievements since receiving their FWIS fellowships are shown in Exhibits 9 and 10. As evident from Exhibit 9, most fellows have been actively involved in their scientific communities. Most have had peer-reviewed journal articles accepted for presentation and presented papers at professional conferences. Many have successfully obtained funding as a PI or co-PI, including federal grants, grants from private foundations, and internal grants. Several have also developed innovative techniques or tools for use in their fields.



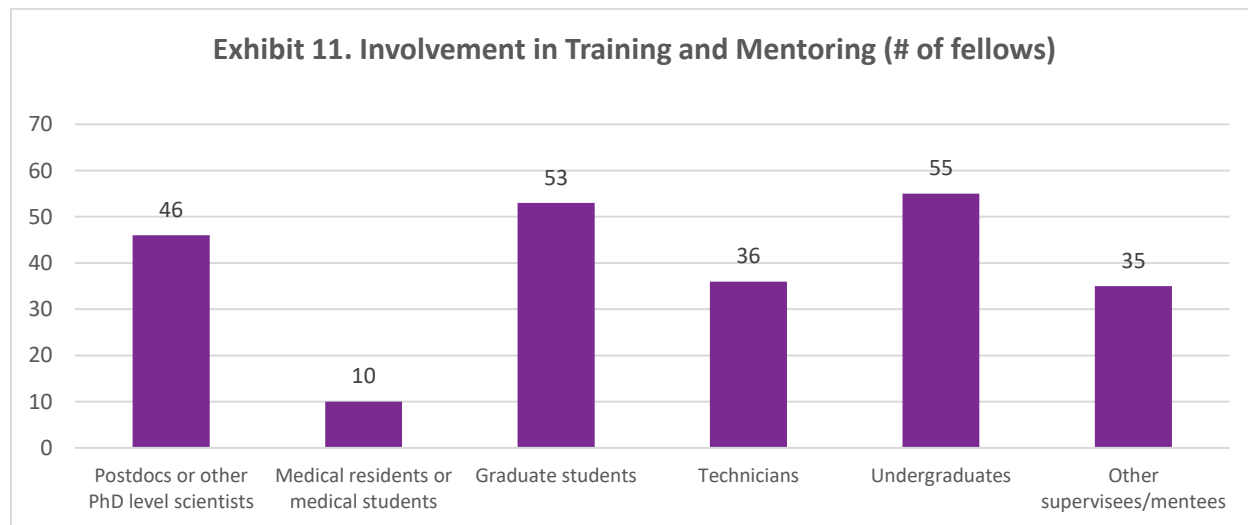
The number of such activities was quantified in the survey, with the total count of various scientific stature achievements among the 64 fellows who participated in the survey shown in Exhibit 10. Fellows have been extremely prolific since their FWIS awards, particularly with regard to peer-reviewed journal articles, conference presentations, published proceedings, and federal grants.

Exhibit 10. Count of Fellows’ Scientific Achievements

Scientific Stature Achievement	Count
Number of papers published in conference proceedings	230
Number of authored or co-authored papers for presentation at regional, national, or international conferences	1,043
Number of articles accepted for publication/published in a peer-reviewed journal	1,191
Number of books published	5
Number of book chapters published	48
Number of patent applications	78
Number of innovative technique/tools developed	74
Number of federal grants received (as PI or co-PI)	181
Number of grants received from private foundation or corporations (as PI or co-PI)	97
Number of internal grants (e.g., a university or Department grant) received (as PI or co-PI)	111

Mentorship

Reflecting the fact that many fellows are motivated by their desire to serve as role models and create opportunities for other women in science, fellows play active roles in training and mentoring the next generation of scientists. The majority of fellows have trained or mentored undergraduate students, graduate students, and postdocs or other PhD level scientists since receiving their FWIS fellowships (Exhibit 11).



In the survey, fellows were asked to estimate how many of each category of trainee or mentee they had worked with since receiving their FWIS fellowship, by gender. The results are shown in Exhibit 12. These

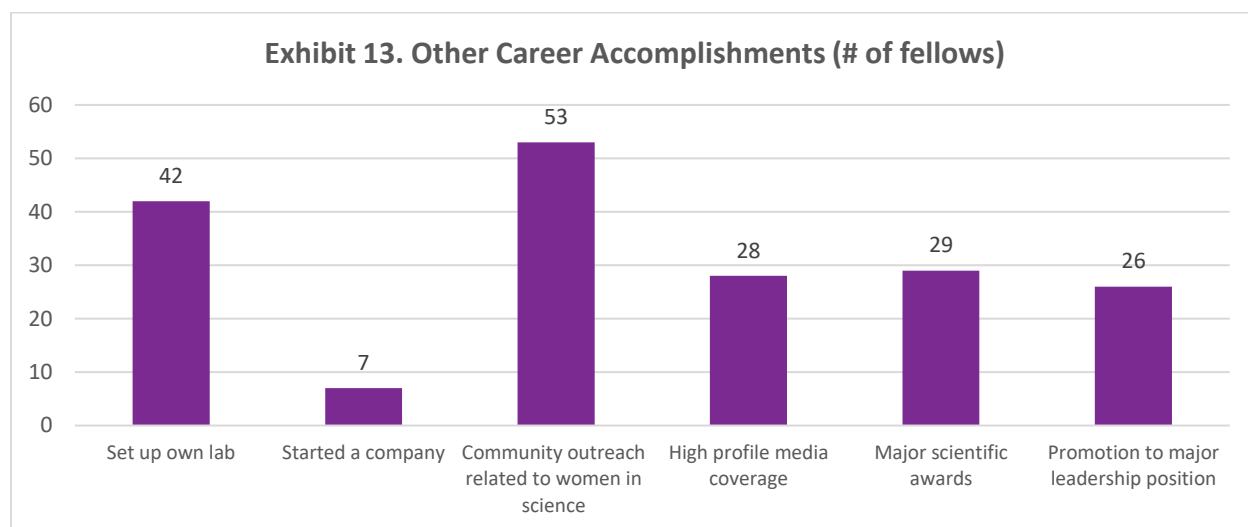
numbers, which are based on the 63 fellows who completed the survey, illustrate the large influence of fellows on the next generation of scientists—both male and female—in their fields.

Exhibit 12. Number of Men and Women FWIS Fellows Have Trained or Mentored

Type of Trainee/Mentee	Men	Women	Total
Postdocs or other PhD level scientists	144	83	227
Medical residents or medical students	11	8	19
Graduate students	130	189	319
Technicians	38	66	104
Undergraduates	265	426	691
Other supervisees/mentees	90	91	181

Other Career Accomplishments

Other significant achievements by the fellows since receiving their fellowship are shown in Exhibit 13.



The majority of fellows have engaged in community outreach activities related to women or underrepresented minority groups in science. Respondents described a number of ways they were actively involved in their local communities, within their universities, and at a national level in efforts targeted toward women, girls, underrepresented minority groups, economically disadvantaged, and first-in-family-for-college students. Specifically, respondents described engaging in outreach designed to encourage minority middle and high school students to pursue careers in STEM fields (n=19), providing peer mentoring and networking opportunities for minority undergraduate and postdoctoral students (n=9), and participating in career panels and workshops (n=9) focused on this issue. Some have started their own programs, including workshops and mentorship programs, and some have led federal grants directed specifically at increasing the representation of women and minorities in their fields. The fellows were involved in “hands on” capacities (e.g., serving as tutors and mentors) as well as in leadership roles, such as serving on advisory boards, chairing committee engagement panels, and serving as faculty advisors.

As evident from Exhibit 13, most fellows have also set up their own labs or research groups. A small number have started companies or non-profit organizations (e.g., biotechnology startups, consultancy LLCs).

Awards and Other Recognition

Although most fellows indicated that they were not motivated by the desire for prestige and recognition (as shown previously in Exhibit 8), many have been extremely successful with regard to major scientific awards, honors, prizes, and appointments. Among the awards and fellowships represented among the FWIS fellows are National Science Foundation (NSF) awards (including NSF CAREER awards), Howard Hughes Medical Institute (HHMI) fellowships, the MacArthur Fellows Program (“genius grants”), Alfred P Sloan fellowships, Ford Foundation Fellowship, Moore Inventor fellowships, Fulbright grants, and Guggenheim Fellowships. Fellows have been appointed as HHMI professors and fellows of the National Academy of Science (NAS). Several have been recognized for their early career accomplishments, including the Presidential Early Career Award for Scientists and Engineers (PECASE) and the NAS Lounsbury Award, and have received various forms of early career support (e.g., the AAAS Marion Milligan Mason Awards, Blavatnik Awards, New Innovator Award from the National Institute of Health, and the Burroughs Wellcome Fund Careers at the Scientific Interface Award). Several have also received awards or prizes from their professional societies, including recognition from the Geological Society of America, North American Neuromodulation Society, Society for Molecular Biology and Evolution, the Society for the Study of Evolution, and the American Physical Society. Finally, some fellows reported receiving excellence in teaching awards from their universities.

In recognition of their accomplishments, many fellows have been profiled in the media for their contributions to their respective fields. Key accomplishments included being quoted in prominent publications (e.g., *National Geographic*, *Smithsonian Magazine*), high profile media coverage (e.g., BBC, NPR, NBC, Univision, *Wall Street Journal*, *Washington Post*), and appearing on television shows (e.g., National Geographic's TV series "Brain Games") or podcasts. Fellows have been named as The Time Person of the Year and appeared on the Time100 (most influential people), the Forbes 30 Under 30, MIT Tech Review 35 Under 35, and Genetic Engineering and Biotechnology News "Top 10 Under 40" lists.

From among the fellows who indicated being promoted to a major leadership position (Exhibit 13), ten reported that they were offered or accepted tenure track or faculty positions and three reported becoming members of a Board of Directors. Other leadership accomplishments included being promoted to the Senior Executive Service level in the Department of Defense, being named to a "Presidential" professorship, being appointed Associate Director of a large graduate department, being appointed as Associate Director of a major institute, being appointed as a center director, and serving in leadership positions in professional societies.

Several other accomplishments were noted by fellows through an open-ended response, including serving as keynote speakers, signing book deals, publishing a children's book, having artwork featured at international exhibitions, developing scientific standards, providing comments on legislation at the House of Representatives, and developing widely-used trainings and workshops.

Insights into Fellows' Most Significant Career Accomplishments

Fellows were asked an open-ended question in the web-based survey about the career accomplishment of which they are most proud, and qualitative interviewees were asked to elaborate on their responses.

Several themes emerged among these responses. For many fellows, the accomplishment of which they were proudest was **securing a tenure track, faculty or assistant faculty position**:

Landing an assistant professor position, getting to do what I love to do, and winning my first research grant as a PI to do it. (Dr. Ming Yi, 2015 fellow)

I am proud of the academic career I have forged as a faculty member in physics, and for the balance of my accomplishments in research, teaching, and mentoring that I have achieved. (Dr. Lisa Everett, 2005 fellow)

I'm most proud of accepting this assistant faculty offer (I received it this spring), but not only because I'm excited to be a professor—I'm excited because I got so much of what I most wanted in a professor job. I really held out for this job, and stuck to my values. I wanted to be at a major public university in a diverse state, I wanted to be a part of a supportive department, I wanted to live somewhere with at least a single friend or loved one nearby, I wanted a chance to advise PhD students... And now I'm starting what is honestly a dream position for me. (Dr. Sarah Ballard, 2015 fellow)

Another common theme was **receiving awards, fellowships or grants for their scientific work**. This recognition was often a point of pride for respondents, with some noting that the FWIS fellowship had been the first of many significant awards for the fellows:

One of the highlights of my career was when I met President Obama as a recipient of the Presidential Early Career Award for Scientists and Engineers in 2012. This award is by blind nomination only, which made the award more special. I had no idea I was nominated and honored to be a recipient. (Dr. Sridevi Sarma, 2008 fellow)

I earned a major grant from the National Science Foundation to continue my research while incorporating undergraduates from communities under-represented in science. (Dr. Sabrina Stierwalt, 2014 fellow)

[FWIS] was definitely my first major award...I think that the recognition helps in the reviewing process and you're receiving other awards...because people know you already have received that award. (Dr. Livia Schiavinato Eberlin, 2014 fellow)

Respondents often highlighted **the development of their own research laboratories or science-based companies** as their most significant career accomplishment. Such endeavors afforded fellows the opportunity to expand the impact of their own findings through the scientific inquiries of their trainees or the translation of their discoveries into practical applications (for example, a home-based hormone monitoring approach for treating infertility and a mass spectrometry pen for treating cancer). They also took tremendous satisfaction in the chance to create a positive, productive scientific culture among those who worked for them:

I'm proud of starting a company that is solving a huge need in women's health, and for hiring amazing people to be a part of it. We're collectively proud of raising over \$5M so far. Our mission is really to transform women's health and to provide a tool that helps women to understand the implications of their hormones for their health. The tool that we developed, which allows monitoring of hormones, essentially can—over the course of a very

short period of time—diagnose the underlying cause of infertility. (Dr. Katie Brenner, 2014 fellow)

It's...really cool to see something that we envisioned and designed then...produced...packed and built a really big platform around it. Now, we're testing it in surgeries...and have done over almost a hundred patient surgeries...I think there's incredible potential to really make an impact in patient care. I'm most proud of being able to create a community of scientists who are all doing such interesting things. (Dr. Livia Schiavinato Eberlin, 2014 fellow)

Despite their own remarkable career achievements, fellows often highlighted (in their web survey responses and in qualitative interviews) the deep gratification they derived from their roles as teachers and mentors. Indeed, many regarded **the achievements of their trainees or the increasing representation of women in their departments** among their proudest accomplishments:

I am extremely proud to have received tenure recently. This is something that I have been working toward (and fretting over) for 20 years, and having achieved it feels like climbing Mount Everest. But hooding my first two graduate students is on par with that in terms of my sense of personal pride. (Dr. Sara Aton, 2008 fellow)

I [am] most proud to have trained a number of extraordinary young scientists that are making an impact in the world. (Dr. Pardis Sabeti, 2004 fellow)

Being able to see my first cohort of graduate students get their PhDs...I am already a scientific mother! It's rewarding to see how they start out as a graduate student one day and they become a mature scientist. And going through their successes. I have a student who got a big fellowship and seeing him cry because he was so happy, it made me cry, too. (Dr. Luisa Whittaker-Brooks, 2013 fellow)

Fellows indicated that their **perseverance and tenacity in the face of adversity** was both an accomplishment in itself and made their other scientific contributions possible. Qualitative interviews suggested that fellows' major discoveries—including contributions as diverse as understanding interactions between immune factors and stem cells and describing the dynamics of the small galaxies from which massive galaxies (like ours) are formed—occurred when fellows combined insights or techniques from multiple areas of study or struck out into uncharted scientific territory. These were labor-intensive efforts that demanded that fellows become fluent in multiple scientific disciplines, develop new ways of thinking about scientific problems, and refine new research strategies or laboratory techniques.

My career has been unique in that I navigated several setbacks along the way, including two R&D (research and development) site closures that resulted in job losses. I am most proud that I have remained resilient and took on new roles because of these situations that broadened my scope as a scientist and R&D Leader. Looking back, these situations were a blessing in disguise and I've become a much more innovative scientist as a result, working at the interface of very different scientific fields. (Dr. Kelly Maria George, 2004 fellow)

Career Accomplishments at the Intersection of Two Fields: FWIS Fellow Shruti Naik



Image credit: L'Oréal USA FWIS

Dr. Shruti Naik, an Assistant Professor in the Departments of Pathology, Medicine and Dermatology at the New York University School of Medicine, explains how her work at the intersection of immunology and stem cell biology resulted in breakthrough discoveries with far-reaching implications for both fields.

[FWIS] allowed me to bring immunology to a...stem cell biology lab that didn't know immunology. My PI felt comfortable taking that risk because I had this funding from L'Oréal. Understanding immune factors that we can give to regenerate tissues could be a completely new way of kickstarting tissue regeneration...For a very long time, people thought that stem cells were protected from the immune system and had a special sanctuary. We discovered that, in fact, they're actively dialoguing with immune cells. Now we're starting to understand the details of this conversation and how that can be manipulated to enhance the function of stem cells.

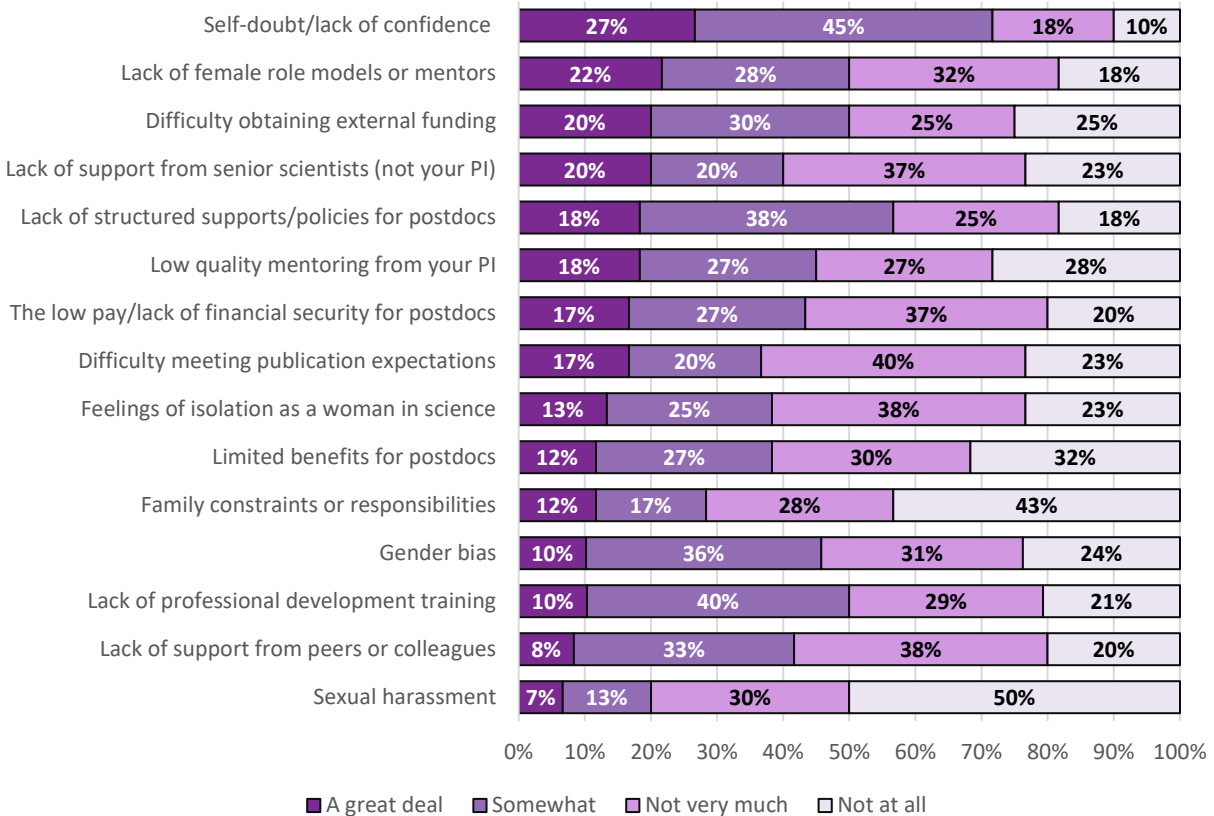
Lessons from FWIS Fellows on Key Challenges and Supports during Postdoctoral Training

To generate contextual information about fellows' personal experiences during their postdoctoral training—which is important in guiding policy recommendations about interventions and supports that could be beneficial to other women scientists during this stage of their careers—fellows were asked about the challenges and supports they experienced as postdocs.

Key Challenges

The extent to which fellows felt their career trajectories were affected by specific challenges during their postdoctoral training is shown in Exhibit 14 (with the challenges ordered from most impactful to least).

Exhibit 14. To what extent did each of the following challenges serve as an obstacle to your career trajectory? (% of fellows)



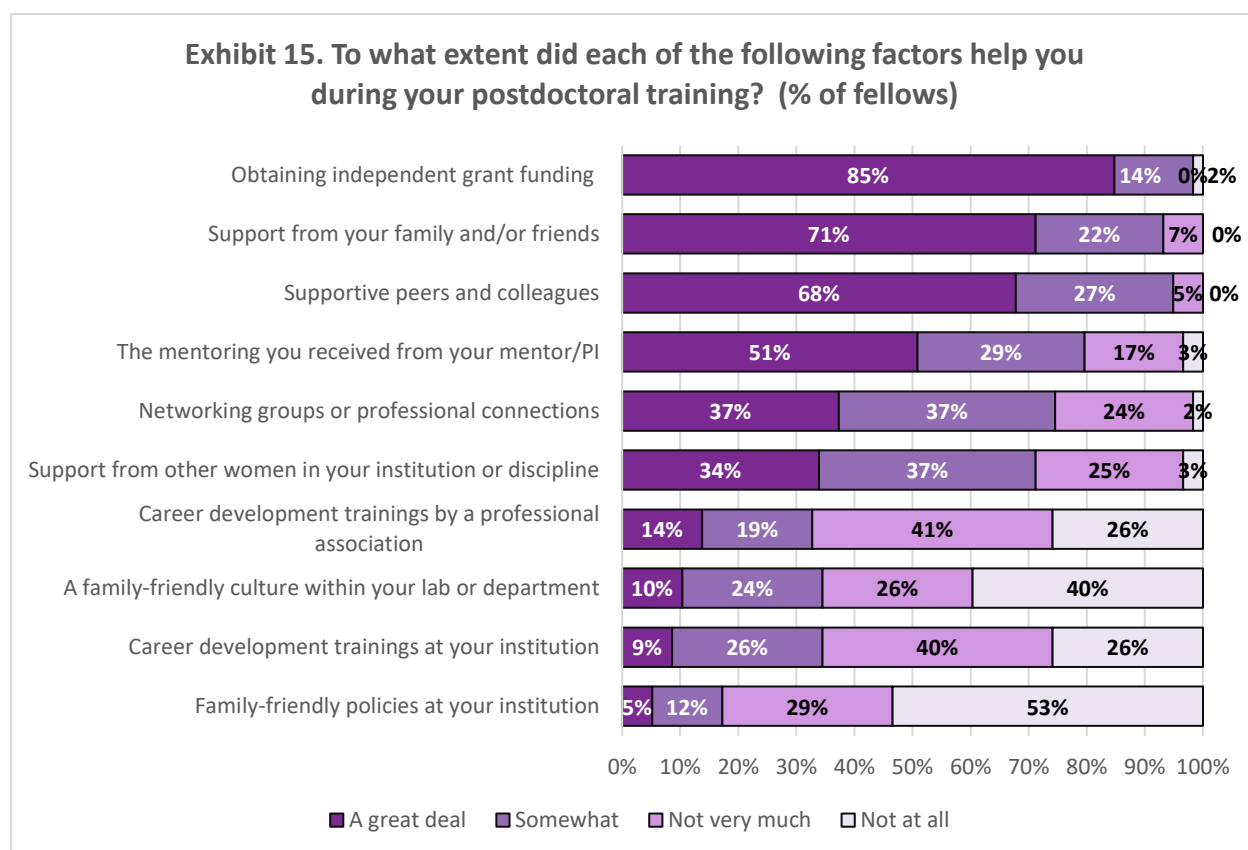
For the most part, fellows were not substantially hampered by the challenges presented to them in the survey (i.e., for most challenges listed, over half of fellows indicated that the challenge affected them “not very much” or “not at all”). However, the most significant challenge for fellows during their postdoctoral training—self-doubt or lack of confidence—was a notable exception. Over a quarter of fellows (27%) indicated that self-doubt/lack of confidence impacted them “a great deal” and 45% felt that it impacted them “somewhat” during their postdoctoral training.

Other challenges that affected a sizeable percentage of fellows were lack of female role models or mentors (which affected 22% of fellows “a great deal” and 28% “somewhat”), difficulty obtaining external funding (which affected 20% of fellows “a great deal” and 30% “somewhat”), and lack of structured supports or policies for postdocs at their institutions (which affected 18% of fellows “a great deal” and 38% “somewhat”). One fellow provided an example of leave time for postdocs being completely at the discretion of the PI/mentor, given the nebulous status of postdocs and lack of structured policies at many universities.

The least common barriers⁷ encountered by web survey respondents were sexual harassment, lack of support from peers and colleagues, lack of professional development opportunities, and gender bias. However, qualitative interviews suggested that sexual harassment still represented a serious obstacle for women in some fields (discussed in “Fellows’ Outlook on Women in Science”).

Key Supports

The extent to which various factors served as supports for fellows during their postdoctoral training is shown in Exhibit 15, listed in order of how impactful the factors were. The most impactful facilitator for fellows was obtaining independent grant funding, which could have included the FWIS fellowship as well as other grants received by fellows at some point during their postdoctoral training (several fellows did receive additional grants). Eighty-five percent of fellows indicated that obtaining independent grant funding helped them “a great deal” during their postdoctoral training. The other major facilitators identified in the survey were support from fellows’ family and/or friends and support from peers and colleagues. In addition, over half of fellows benefited either a great deal or somewhat from the mentoring received from their official mentor/PI, networking groups or professional connections they developed (including senior scientists other than their official mentor/PI), and support from other women in their institutions or disciplines.



⁷ Because of the wording of the survey question (“In thinking specifically about the postdoctoral stage of your career, to what extent did each of the following challenges serve as an obstacle to your career trajectory?”), a negative response could mean either that 1) the fellow did encounter the challenge but that it did not serve as an obstacle or 2) the fellow did not encounter the challenge at all.

The least impactful facilitators for fellows personally were family-friendly policies at the fellows' institutions, career development trainings or workshops offered by the fellows' institutions, a family-friendly culture within fellows' labs or departments, and career development trainings or workshops offered by professional associations.⁸

In an open-ended follow-up question, fellows were asked about what other supports would have been helpful to them during this stage of their careers. Common themes among respondents included the value of strong social networks (particularly peer support networks and networks of women postdocs) to help respondents navigate the postdoc stage, the need for stronger mentoring (especially more women mentors and better training and accountability of mentors), the need for professional development trainings (e.g., teaching, mentoring, grant writing, personnel management, negotiating, setting up a lab, transitioning outside of academia as well as the progression within academia), the importance of benefits and institutional support (e.g., parental leave, childcare, health insurance, mental health care, postdoc organizations) for postdocs from both universities and funding agencies, and more independent funding for postdocs (and for a longer period of time).

Insights into Fellows' Success

To provide additional insights into fellows' experiences during their postdoctoral training and better understand the factors that were responsible for their success, fellows were asked an open-ended question about what they thought contributed most to their success during this phase of their careers.

Many fellows' responses reaffirmed the main finding in Exhibit 15, which was the fact that **the independent funding provided by FWIS (or other grants) supported the pursuit of innovative and high-risk, high-reward research topics** that allowed respondents to stand out in their respective fields and author high-impact publications. Illustrative quotes are included below, with additional detail about the use and benefits of the FWIS fellowship provided later in this report.

The FWIS fellowship was uniquely helpful because it allowed me to transition my research program in a direction that was both distinct from my postdoctoral advisors, and which was high risk/high reward. The work I proposed was technically challenging, expensive, and had a high risk of failure. The fellowship allowed me to pay my own salary, which gave me the independence to grapple with the technical challenges on my own time. It also allowed me to invest in equipment which made my experiments possible. The inherent risk and expense of these experiments meant that pulling them off successfully made me a true standout in my field when I entered the job market...I would have never developed these techniques if not for the independence I could afford thanks to the fellowship. (Dr. Sara Aton, 2008 fellow)

Postdoctoral fellowships, including FWIS, were critical for my success during the postdoc phase of my career because these awards provided me with the independence and flexibility to direct my own research and boosted my CV. (Dr. Stacy Copp, 2018 fellow)

Being able to pursue a research topic of my own without being constrained by what my supervisor had funds for. (Dr. Sridevi Sarma, 2008 fellow)

⁸ It should be kept in mind that a negative response (e.g., "not very much" or "not at all") could mean either that the support was not in place at all or that the support was in place but was not helpful to fellows.

One way to convince a lab head that your avenue is worthwhile is to secure funding, generate some preliminary data, and make a pitch for it. I think this is where L'Oréal's funding was instrumental. It allowed me to bring my own ideas into a lab. (Dr. Shruti Naik, 2016 fellow)

It actually afforded me the opportunity to pursue that side project, which has now turned into my career. Having some money that allowed me to get started on that project is what really allowed me to do what I'm doing today. (Dr. Katie Brenner, 2014 fellow)

Nearly all respondents identified **supportive family, friends, advisors, and mentors**—particularly peers with similar experiences and female mentors—as instrumental to their success.

I was very fortunate to have a close circle of family members, friends, and professional mentors who believed in me and encouraged me throughout my postdoctoral career. (Dr. Lisa Everett, 2005 fellow)

I benefited from incredibly supportive mentors and collaborators who believed in my capabilities as a scientist and pushed me to be more rigorous. (Dr. Molly Schumer, 2017 fellow)

Support from my mentors and peer network—particularly other women at similar career stages—were essential to my success. (Dr. Amy Orsborn, 2016 fellow)

Excellent guidance from my mentors, which included my PI and other senior scientists who were influential in my field. They gave me guidance and promoted my work and nominated me for invited talks and leadership roles in professional societies. (Dr. Tiffany Santos, 2009 fellow)

During my postdoc, I was lucky to have a number of strong mentors, as well as excellent colleagues in my research group and a great peer network in my department. Especially with respect to mentors, my postdoctoral adviser provided outstanding guidance as I learned a new research field, providing me with room to explore and make my own mistakes but also plenty of expertise and guidance when I needed it most. He also strongly supported my participation as a member of the research community through publication and attendance at academic conferences. (Dr. Jennifer Laaser, 2014 fellow)

Community: having a network of female mentors who have walked, or are walking, the path I am currently on has been critical toward my success. It is something I wish I would have had earlier in my career. (Dr. Brecca Gaffney, 2018 fellow)

Finally, some fellows noted that **perseverance, confidence, creativity and a strong work ethic** contributed greatly to their success. Indeed, qualitative interviews made it clear that the biggest scientific contributions of fellows' careers had not come quickly or easily. FWIS often helped fellows to persist in risking their time and laboratory resources on innovative forms of inquiry for which the payoff was uncertain:

Creativity was the most important factor in helping me succeed. I was lucky that many people supported my independent thinking, including the FWIS team. (Dr. Arpita Bose, 2013 fellow)

Perseverance, confidence, and a little bit of luck, to be honest. (Dr. Anne McNeil, 2006 fellow)

Academia requires a tenacity and ambition that cannot be met with intelligence alone. (Dr. Brecca Gaffney, 2018 fellow)

I had a significant amount of preliminary data that I got through the financial support of the L'Oreal fellowship. [FWIS can support] projects that are high risk, high payoff that you will do as an independent researcher where you can collect preliminary data now that will help you with proposals in the future. (Dr. Luisa Whittaker-Brooks, 2013 fellow)

Scientific Staying Power: FWIS Fellow Sridevi Sarma



Image credit: Will Kirk

Dr. Sridevi Sarma, Associate Professor of Biomedical Engineering at Johns Hopkins University and Associate Director of the Institute for Computational Medicine, describes how receiving the FWIS fellowship helped her to chase her scientific vision while also raising young children.

The FWIS fellowship came right after I had my second child. I was exhausted and started to lack confidence in my ability to pursue an academic career while being a mom. I was thinking, "Oh my God...how the hell am I going to do all this? Am I crazy?" The timing [of the FWIS award] was fantastic to kind of give me that lift that I needed at that time. When I learned that I was to be a fellow, I was boosted with positive energy. My postdoc advisor was thrilled and encouraged me to pursue independent research and was supportive of anything I wanted to pursue. I formed collaborations with clinicians, bought equipment, and even hired an undergraduate intern to gain mentoring experience. All of these events brought me back to pursuing my dreams of becoming a researcher and professor. I was definitely considering potentially stopping temporarily, if not permanently... My son was [about] two years old at that time and I was pregnant...it was just the timing...I was definitely considering potentially stopping temporarily, if not permanently...but there was something about that phone call...it was exactly sort of the news I needed to keep me going.

Academically Alive: FWIS Fellow Jaime Barnes

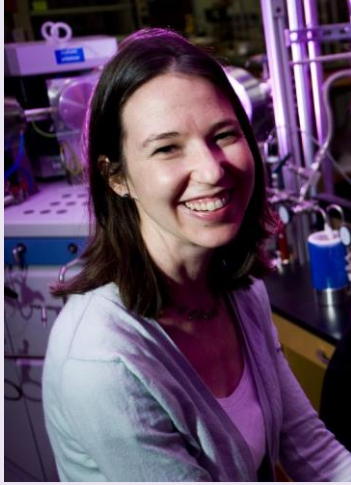


Image credit: Photographer is Sasha Haagensen. Also property of the Jackson School of Geoscience (UT-Austin).

Dr. Jaime Barnes, Associate Professor of Geological Sciences in the University of Texas at Austin School of Geosciences, explains how critical an additional year of postdoc funding can make an (academically) life-or-death difference for women in STEM fields.

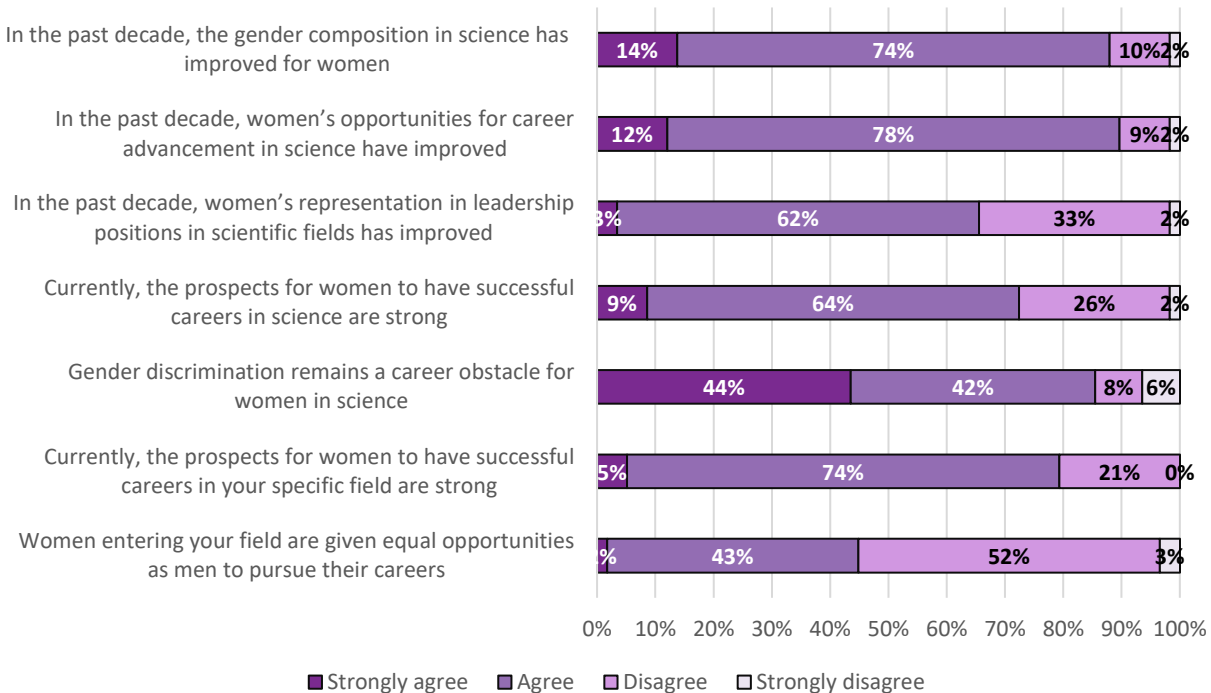
This funding gave me time to complete new research projects and publish additional papers- both critical to pursuing an academic position. Because of this fellowship, my research and funding profile was strengthened, making me a more competitive candidate and ultimately helping me to secure a tenure-track position at a top academic institution. In addition, the fellowship gave me a year of financial security, allowing me to start a family. That additional year of [postdoctoral] funding, it essentially helps keep you academically alive...That's kind of a period of ultimate freedom. You get to do your own research and have your own ideas and really develop as an independent scientist, and so, I could complete more projects, publish more papers, apply to more jobs. And I felt the longer I was in a postdoc position, the job interviews and the job offerings that I was getting were better. But I got really lucky, I got that extra year of money that kept me academically alive and gave me some stability, where I look at other women that are just as qualified that don't get that extra year of funding and it makes it difficult for them to stay in academia.

Policy Recommendations to Improve Retention of Women in Science

Fellows' Outlook on Women in Science

In response to a series of structured questions asking fellows how much they agreed or disagreed with various statements about the current outlook for women in science generally and in their specific fields, fellows' outlooks appeared to be mixed (Exhibit 16). On the one hand, the vast majority of fellows agreed that gains had been made in the past decade for women in science, particularly in regard to the gender composition (88% agreed or strongly agreed) and women's opportunities for career advancement (90% agreed or strongly agreed) and, to a lesser extent, that women's representation in leadership positions had improved (66% agreed or strongly agreed). Similarly, the majority of fellows agreed that the current prospects for women to have successful careers in science generally (72%) and in their specific fields (79%) are strong. However, most women also felt that gender discrimination remains a career obstacle for women in science (91% agreed or strongly agreed) and felt that women entering their specific fields are not given equal opportunities as men (55% disagreed or strongly disagreed that women entering their fields are given the same opportunities as men to pursue their careers).

Exhibit 16. Fellows' Perceptions of the Prospects for Women in Science (% of fellows)



This mixed pattern was also evident in fellows' responses to open-ended survey items and in qualitative interviews. Fellows noted that STEM fields have a long way to go toward achieving gender parity. They described gains in representation as relatively small and noted that gender bias and retention continue to be issues for women in STEM fields. They attributed the latter, in part, to the lack of benefits (e.g., maternity leave, childcare) and family-friendly policies (scheduling meetings in the afternoons) that foster a healthy work/life balance. Qualitative interviewees discussed these issues in depth, expressing particular frustration with slow gains in gender-related climate and the fact that parenting obligations were too often seen as a shortcoming or liability to be covered up or compensated for in academic circles.

Personally, I was starting a family at that point. So, I was having my first child and I noticed that... as a mom, there are a lot more responsibilities with the baby at first...I felt that [the lack of family leave] was putting us in a point of disadvantage and I had a lot of other colleagues that are female that were feeling that way too... Of course [men's] CVs end up being more competitive because we have these other obligations...It's not like I would take a long maternity leave, but the other postdocs that were male, they were back the next day. So, they're making more progress and being more productive...and getting more things done because... it's just a completely different scenario... (Dr. Livia Schiavinato Eberlin, 2014 fellow)

During qualitative interviews, it was suggested that gender bias persisted across scientific disciplines, across institutions, and at all levels of achievement. Interviewees noted widespread gender bias in

hiring, publication review processes, and grant selection processes. They also reported a variety of “everyday” experiences of gender bias and gender-related hostility or microaggression (such as being asked to do secretarial work by a male academic peer).

One of the biggest challenges being a woman in science is the consistent, for lack of a better word, microaggression from male engineers that aren't really aware that they're being microaggressive. The repetitive critique of your work that does not seem to be equally distributed across genders has the potential to make me question, “Is that because of the work, or is that because I'm a woman?” (Dr. Brecca Gaffney, 2018 fellow)

[Male academic colleague] went right to sort of a list of chores that he wanted me to do for him...I was just really baffled. I was like, “Why?” Why are you asking me to do this, this list of secretarial chores for you? That doesn't make any sense. I'm still sort of baffled by this...I definitely have days where... I'm surprised that...these things still happen. (Dr. Sara Aton, 2008 fellow)

Qualitative interviewees also noted that the gender gap in confidence at various levels of study and career prevented high-achieving women scientists from fully believing in and promoting their own achievements or ideas.

Even though they're so accomplished, their confidence levels don't match their accomplishments...What I noticed when I teach, and this is at the undergraduate level, so it starts very early on, is that women actually can perform very well...There's more women, percentage-wise, that are in the top of the class. So, they are actually outperforming the men but they, when they do well, it's not like they're talking to their peers. It's not like they're telling anybody. (Dr. Sridevi Sarma, 2008 fellow)

Still, when asked about the most positive changes they had observed for women in science, fellows cited several positive developments, such as

- the growing prevalence of women in scientific fields and leadership positions,
- cultural shifts, including greater awareness around gender bias issues and sexual harassment,
- hiring policies that seek to combat the underrepresentation of women and people of color in science, and
- family-friendly policies (and more recognition of the importance of work-life balance)

Qualitative interviewees tended to express a strong, positive outlook on the future of women in science despite the challenges they reported. They observed a “rising tide” transforming gender-related academic climates and improving the representation of women in their disciplines (particularly at lower academic levels). Many saw themselves playing a key role in these changes through creating new scientific cultures in their laboratories and through mentoring younger women.

There's this rising tide of change where not only are women more represented at the career level that I'm currently at versus when I was just getting started in research but...there's really growing awareness as well as representation. I think both of those things are really important in order to make this a place where everyone is coming to the table and feeling like they have a seat. (Dr. Sara Aton, 2008 fellow)

Changing the Way Science Is Done: FWIS Fellow Pardis Sabeti



Image credit: Harvard University

Dr. Pardis Sabeti, Professor of Immunology and Infectious Diseases in the Harvard School of Public Health, shares her outlook on the current climate for women in science.

The higher you go, the more you recognize the systemic challenges women face. Our professional world was mainly created by a small minority of people, mostly male in gender, and so was not designed with the interests and needs of women and minorities in mind. So on one hand, there's this need for a more inclusive culture, and then on the other, there remain biases that we have to take on head on. It's all there, and many of us experience it in some way every day. At the same time, I think it's one of the most exciting times to be a woman, because there is enough of a collective force to actually make a change and a positive impact. It's not lost on me that having a tenured position at a major institution has given me this amazing opportunity and support to help bring that change. And I truly believe that little by little [we] can change not only science, but the way that science is done.

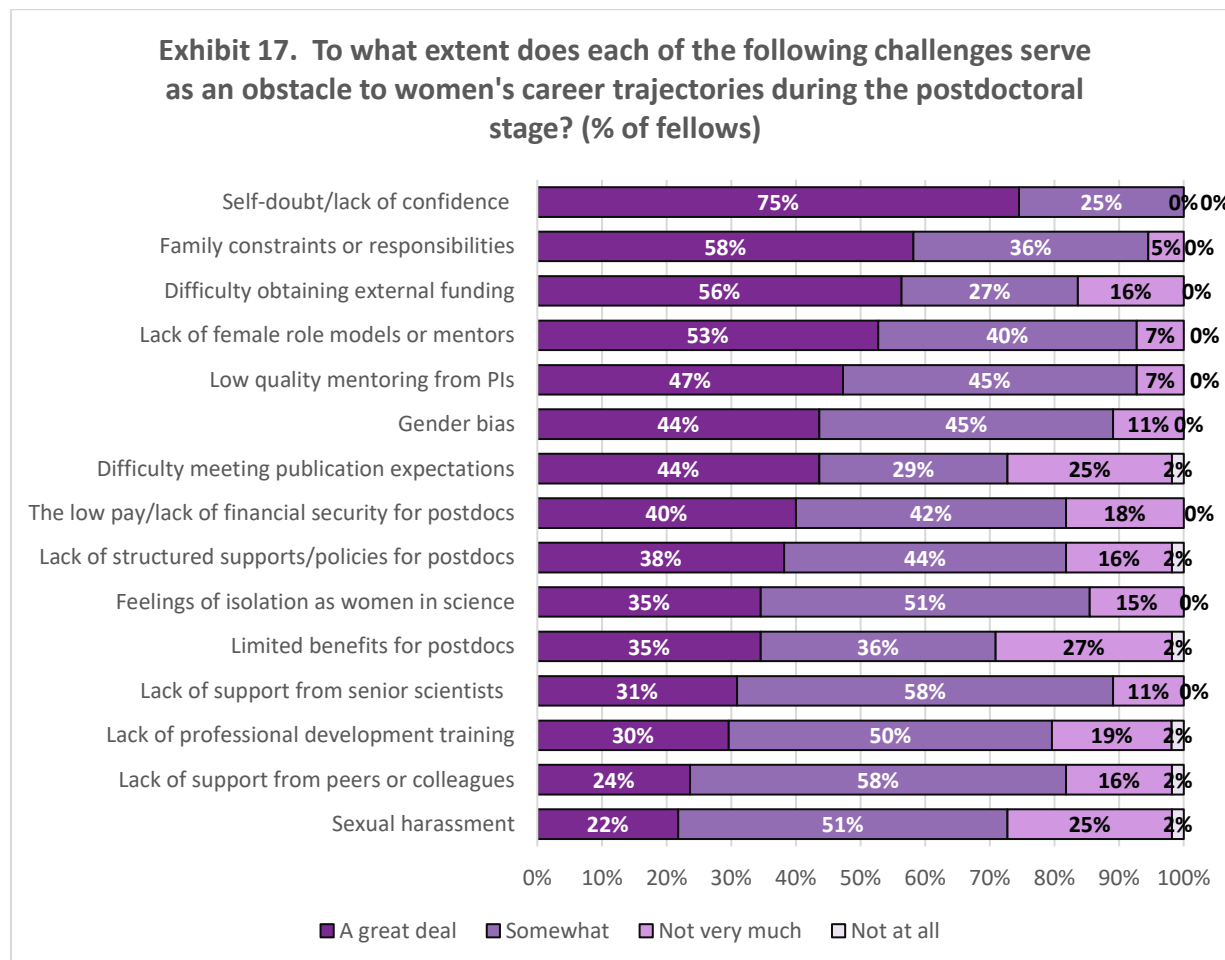
Existing Challenges for Women during Postdoctoral Training

To frame the policy recommendations for what interventions are needed to improve the postdoctoral experience for women and facilitate retention in science, fellows were asked to identify the most serious challenges to women during the postdoctoral phase of their careers. Using the same set of challenges as those covered when asking fellows about the challenges they encountered personally, fellows were asked about the extent to which each challenge served as an obstacle to women's career trajectories during their postdoctoral training. The results are summarized in Exhibit 17.

Fellows' perceptions of the *relative* impact of challenges facing women scientists during postdoctoral training are largely similar to their personal experiences (Exhibit 14). Notably, self-doubt or lack of confidence was the most impactful challenge for fellows personally and the one that they observe as being most impactful for other women. Similarly, difficulty obtaining external funding and lack of female role models were among the top challenges the impacted fellows during their training and that they see as among the most significant challenges for other women postdocs.

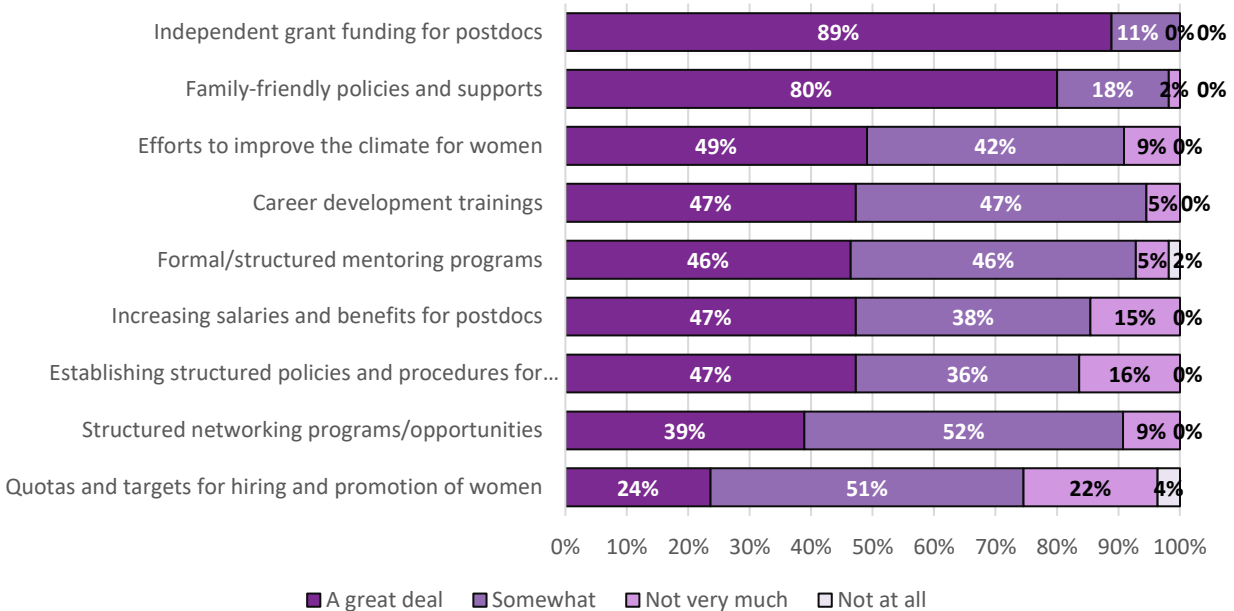
However, a few differences between fellows' personal experiences and their outlook for other women scientists during postdoctoral training are evident. First, the fellows tended to perceive each challenge as having a significant impact on women postdocs (with all challenges felt to be "a great deal" or "somewhat important" by the majority of postdocs), even if they were not substantially impacted by the challenges themselves; in other words, the absolute rating given to each challenge is higher in Exhibit 17 than what was observed in Exhibit 14. Second, with regard to the relative influence of specific challenges, although the challenges were largely ranked the same, fellows were clearly aware—based on their experiences working in academic settings and training and mentoring the next generation of

scientists—that family constraints and responsibilities have a major impact on the success of women postdocs generally (95% of fellows felt that this challenge affected women “a great deal” or “somewhat” during postdoctoral training) even though they personally may not have been affected by this challenge.



Most Promising Supports and Interventions for Women during Postdoctoral Training
 Fellows’ perceptions of the specific supports or interventions they perceive to be most effective in promoting women’s career advancement in the postdoctoral stage are shown in Exhibit 18.

Exhibit 18. To what extent is each support/intervention effective in promoting women's career advancement in the postdoctoral stage? (% of fellows)



Reflecting several of the biggest challenges identified in Exhibit 18, fellows’ top recommendations were 1) independent grant funding for postdocs (which 89% of fellows identified as being “a great deal” effective in promoting women’s career advancement in the postdoctoral stage) and 2) family-friendly policies and supports such as dual career placement programs, parental leave, childcare support, flexible working arrangements, which 80% of fellows identified as being “a great deal” effective). These two interventions were clearly perceived as having the greatest potential to positively impact women during their postdoctoral training.

All other proposed interventions were viewed as promising, including efforts to improve the climate for women in academic or other training settings (e.g., trainings and programs to reduce gender bias and sexual harassment), career development trainings (e.g., grant writing, publishing, career guidance, media training, project management, leadership), formal or structured mentoring programs (e.g., training for mentors/mentees, group/committee-based mentoring, matching programs), increasing the salaries and benefits associated with postdoctoral positions, the establishment of structured policies and procedures for postdocs within an institution (e.g., postdoc office, grievance procedures); structured networking programs or opportunities; and the use of quotas and targets for hiring and promotion of women.

Insights into Key Policy Changes Still Needed

All fellows were asked an open-ended question to elicit their recommendations for the single most important change or development still needed to advance women’s careers in science during the postdoctoral stage, with fellows’ ideas discussed in more detail during the qualitative interviews. One of

the most common themes that emerged from these responses was the need for **structured supports for women who start families during the postdoctoral stage**. Postdoctoral trainees face enormous pressure to be productive during this stage of their careers, which also coincides with the age when many women want to start families. Further, women postdocs are often partnered with another academic, who is typically experiencing similar career pressure. As a result, many women—who still assume more of the burden for family responsibilities—end up giving up at this stage of their careers. Therefore, many fellows felt that the establishment of family-friendly policies that ensure parental leave, provide for adequate salaries and benefits, ensure affordable, high-quality child care, and support dual-career couples (e.g., career placement assistance) would allow women to remain in science during this stage of their careers. Similarly, qualitative interviewees stressed the importance of access to childcare and suggested that universities should ensure it was available (and affordable) to postdocs at their institutions. They also stressed the need for supportive family leave policies for postdocs, proposed that federal grantmaking agencies change their policies to allow paid family leave on their grants, and suggested offering competitive grants to pay for technician time to support researchers who were preparing for birth and primary caregiving. Fellows noted that such structural supports must also be accompanied by a cultural shift among PIs, who may view the decision to have children negatively, or future employers, who may view gaps in resumes (associated with maternity leave) negatively.

Studies show that when women become mothers, they are more likely to begin earning less than men and to receive fewer career advancement opportunities than men. Because the postdoctoral period often lines up with a time in life when many women choose to have children, it is crucial that postdocs have access to paid parental leave, adequate benefits, and salaries sufficient to pay for quality childcare. Without these options, we are likely to continue to see an attrition of women from science and engineering at the postdoctoral career stage. (Dr. Stacy Copp, 2018 fellow)

The biggest change still needed is to move beyond the gender bias that doesn't allow women to be taken seriously as scientists. One example of how to address this issue is better parental leave policies or external fellowships for women at the postdoc stage so that women are not forced to cut leave short before they are fully ready to return to the workforce or work overtime to cover unspoken... "gaps" in their CVs. (Dr. Sabrina Stierwalt, 2014 fellow)

I think a lot of women feel that they're going to slow down for the first year after having a baby ...you just gave birth to a child and taking care of a newborn is not a trivial task. Dedicating a concrete resource to support primary care givers at this critical stage by providing a year of technical support, someone who can do physically your experiments or analyze your data, could be instrumental for retaining talent in academia. (Dr. Shruti Naik, 2016 fellow)

Fellows underscored the urgency of addressing family-unfriendly academic climates in order to retain women scientists past the postdoctoral stage and to allow them to compete successfully against male colleagues (with fewer parenting obligations) in intensely competitive academic job markets. Some viewed improvements in family-friendly culture as being tied to the need for improvements in the broader climate for women, which would allow more women to be successful at this stage in their careers.

I think family leave policies and sharing responsibilities is [crucial]...At the postdoc stage, it's when you also may be thinking about starting a family, and there are these challenges with competitiveness and getting the job...It's your last stage [before] you actually get an academic job or research job. So, having better policies that assure that women and men have the appropriate amount of time to dedicate to—if it's a desire for family, leave and stuff like that. I think that would also help with equality. (Dr. Livia Schiavinato Eberlin, 2014 fellow)

The importance of **independent funding for postdocs** was also described as one of the most critical policy changes that would reduce attrition among women at the postdoctoral training stage. Some fellows argued that independent funding that helps to bridge the transition from the postdoctoral stage to academia was the best solution to attrition among women in science.

During the postdoctoral stage, the most important change that is still needed to advance women's careers in science is more opportunities to secure independent funding. As the number of strong candidates continues to increase, I believe that establishing a line of funding as a postdoc is critical to securing a faculty position. As federal grants become more difficult to secure, increasing the number of other funding opportunities, particularly for female postdocs, will drastically help advance their careers. (Dr. Brecca Gaffney, 2018 fellow)

Funding that a postdoc can take with her into the first few years of an academic position is probably the single biggest need and the one challenge that causes women who hoped to go academic to turn around at the last minute...Across the board, science needs to be better funded, but it is hardest when you are young, establishing your lab, and also starting a family in your few "off work" hours. Stable funding would catapult these young women to success and convince them to stay in academia...You just get constant "no's" at a time when you're tired and you've got small children...It's just a bad downward cycle. I feel like people exit. I just feel like they say, "It's not worth it to me." I think that [bridge] funding could really make a difference because there are so many creative ideas these women have. If they just didn't have to be begging for money, constantly getting turned down and locked in the basement, they might succeed...they might change the world. (Dr. Katie Brenner, 2014 fellow)

An increase in post-doc funding opportunities. A post-doc is a necessary bridge from graduate school to an academic position, yet funding is extremely limited. Additional support is needed to provide more and stronger bridges for women, allowing them time to continue to strengthen their research resume thus improving job opportunities. (Dr. Jaime Barnes, 2007 fellow)

Another critical need for the advancement of women's careers during the postdoctoral stage was **stronger mentorship**. Some fellows felt that better training of PIs as mentors and managers was needed.

The entire scientific infrastructure needs to be redesigned to ensure that lab PIs are trained as both mentors and managers, so that they too can create a positive working climate for all scientists. (Dr. Pardis Sabeti, 2004 fellow)

There's not any formal training on mentoring...you have the scientists that are trained on their science and then are put into this role of being a mentor...But how is the quality of mentorship assessed? On an institutional level, there needs to be more oversight of junior faculty, and how they're mentoring their young graduate students and also how are they being mentored. (Dr. Brecca Gaffney, 2018 fellow)

Many emphasized the need for more strong, female mentors as well as greater representation of women in leadership positions. Guidance from senior women in science who can speak to the difficulties of balancing career, family and outreach—even if these women are not in the exact same field as the postdoc—was perceived as critical. Along with stronger mentoring, greater career advocacy for young female postdocs was a related suggestion, including efforts to promote them as invited speakers, nominate them for awards and honors.

I believe that a well-rounded support system specifically targeted at mentorship for postdoc women with female faculty members in similar fields would help tremendously, especially on balancing career and family and outreach, and how to survive and thrive in it all. (Dr. Ming Yi, 2015 fellow)

Postdocs are trainees, but they are also experts in their fields, and have PhDs to prove it! It is critically important that young female postdocs be recognized as subject matter experts in the form of awards, honors, invited talks, etc. I think many people still pass over young women when asked to invite a speaker to a conference or name a young leader to feature in a news article, and this can have a significant negative impact on an emerging career. To address one aspect of this, I developed a database of women in STEM at my institution, MIT, so everyone has a resource of talented and diverse speakers for their events: wisdm.mit.edu (Dr. Ritu Raman, 2017 fellow)

[There is a need for] increasing the number of female mentors. As women postdocs in science, we need more examples of established scientists to both support us in our work, but also who can support us as we navigate systemic biases. Mentors who can also tell us that, "No, that's not okay that somebody told you that," to validate feelings of, "Am I uncomfortable because of what was said or am I just uncomfortable because I'm insecure about everything as a postdoc?" [The importance of] having a sounding board for a trainee in a safe mentoring environment...can't be overstated. (Dr. Brecca Gaffney, 2018 fellow)

I think having mentorship that is sort of intentionally gender matched is helpful...No matter what your gender, there are certain challenges that you face that are just going to be specifically linked to that. I think having a role model... where their role is not just to mentor you with regard to your career, but specifically with regard to your career in your gender. I think that having that outside perspective is really helpful, if for no other reason than having a sounding board to ask, "Have you ever faced something like this? Is it reasonable that I'm facing this thing at this time, or is this something that I should report?" (Dr. Sara Aton, 2008 fellow)

Professional development training tailored to postdoctoral students was also identified a promising intervention. Structured training opportunities and workshops offered by institutions specifically for postdocs were recommended as an important strategy. Some noted that professional development

activities focused on career trajectories would help reduce the uncertainty (particularly during a time frame when many women are trying to plan when they will start families). Ideally (but typically not in practice), this type of career guidance would take place in the context of mentoring or as a grant funding requirement.

Having institutions implement (and perhaps move to mandatory) career development activities specifically for postdocs (most of these are for grad students). Postdocs at most institutions sometimes lack identity and support. They are not considered a grad student but at the same time they are not considered staff or faculty. Thus, their rights are somewhat obscure (if they have any...). (Dr. Luisa Whittaker-Brooks, 2013 fellow)

There needs to be structured training and mentorship for career placement for postdocs, as well as transparency about how hiring actually works in academia and industry. When postdocs understand that academic hiring is entirely about networking, and when their mentors and supervisors actively support and expand the postdocs' network building, then the postdocs will have the tools they need to achieve better career placement during and after their postdoctoral stage. (Dr. Sydney Schreppler, 2017 fellow)

I think the most important thing is more clearly laying out the process, expectations and requirements of the next stages of the career. This is nuts and bolts mentoring that many postdocs don't get. (Dr. Lindley Winslow, 2010 fellow)

There should be more formalized training [in management] and ...we need to start focusing more on management science as well. There are ways of being more efficient and optimizing both the work that we do, and how we do our work. We need to create a culture that promotes efficiency and empowers people to do their best work. The sooner lab PIs realize that much of their job is managing science, not doing science, the sooner they'll really start to assume that charge as their own. (Dr. Pardis Sabeti, 2004 fellow)

We need to support women at that critical transition [to the first permanent position] because that's a critical point of attrition in academic science. A training that I think would be particularly helpful is a leadership and management seminar...as an offering for senior postdoc. We think that things like negotiating and conflict resolution are just natural skills, and the truth is they're not. They're learned skills and if we empower women with these tools at early stages and give them the confidence to advocate for their careers, I think that would be extremely beneficial. (Dr. Shruti Naik, 2016 fellow)

One fellow commented that professional development training should include strategies for finding jobs outside of academia (including starting one's own company, working in policy, working in various roles in industry), as stable academic positions are extremely scarce in some fields.

Finally, a few web survey respondents pointed to the need for strategies to **improve self-confidence among female postdoctoral students and to foster supportive and unbiased climates**. Respondents described how gender bias obscures women's status as subject matter experts and can be "devastating for morale".

Women still lack confidence and this affects the way they communicate their science and negotiate their salaries and packages in academic positions (and likely industry as well). We

need more effective programs that are affordable and accessible to postdoctoral women that address these challenges...What's the most important sort of skill that...we can give to postdoc women? There's no question it's this communication skill and also how you present yourself...No matter whether we like it or not, there's definitely unconscious biases and there's still, these [STEM] departments tend to be male dominated and...how you present can change your game. It's unfortunate [but women need training] to basically deal with the biases so that they're always seen in a positive light. (Dr. Sridevi Sarma, 2008 fellow)

Meaningfully Matched Mentorship: FWIS Fellow Livia Schiavinato Eberlin



Image credit: University of Texas

Dr. Livia Schiavinato Eberlin, MacArthur Fellow and Assistant Professor of Chemistry at the University of Texas at Austin, describes how combined work-life mentorship could support women's persistence in scientific careers.

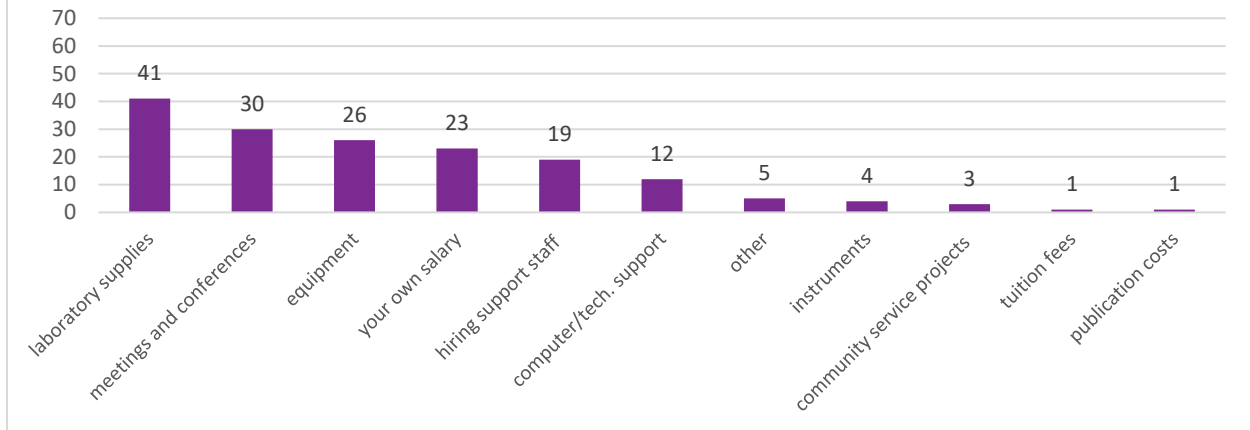
All of my mentors at Stanford were men, and the few women that I saw in the...professor positions, a lot of them had actually never had a kid...So, I always felt like my talent and my passion was for going into academia, but I always thought...I don't think I can do it because I really want to have kids, too and it doesn't seem to be compatible... that was really something that made me think maybe I shouldn't do what I feel like I'm meant to do because there wasn't anyone that I could relate to...The [My Science My Life] platform that I'm trying to build here at UT is a mentorship program that gets you connected to a mentor with a mentee...[not] just a random connection, but people that can relate both professionally and personally...Personally I need help figuring out [things] like how do I manage my three kids, how do I do school, how do I do drop off, how do I have dinner with this professor who is visiting—and that's when I'd go to someone that also has...that experience.

The Impact of the FWIS Fellowships on Fellows' Careers

Use of the FWIS funding

The specific manner in which fellows used the FWIS funding is shown in Exhibit 19. Fellows were asked to indicate the top three ways that they used their funding, from among the allowable activities shown. As evident, the most common uses of the grant were purchasing laboratory supplies, attendance at meetings and conferences, the purchase of equipment, the fellows' own salary, and hiring of support staff (including undergraduate and graduate students). Other uses of funding included computer and technical support, the purchase of instruments, community service or outreach activities, tuition, publication fees, travel, support for a visiting collaborator, and an internship that complemented the fellow's research.

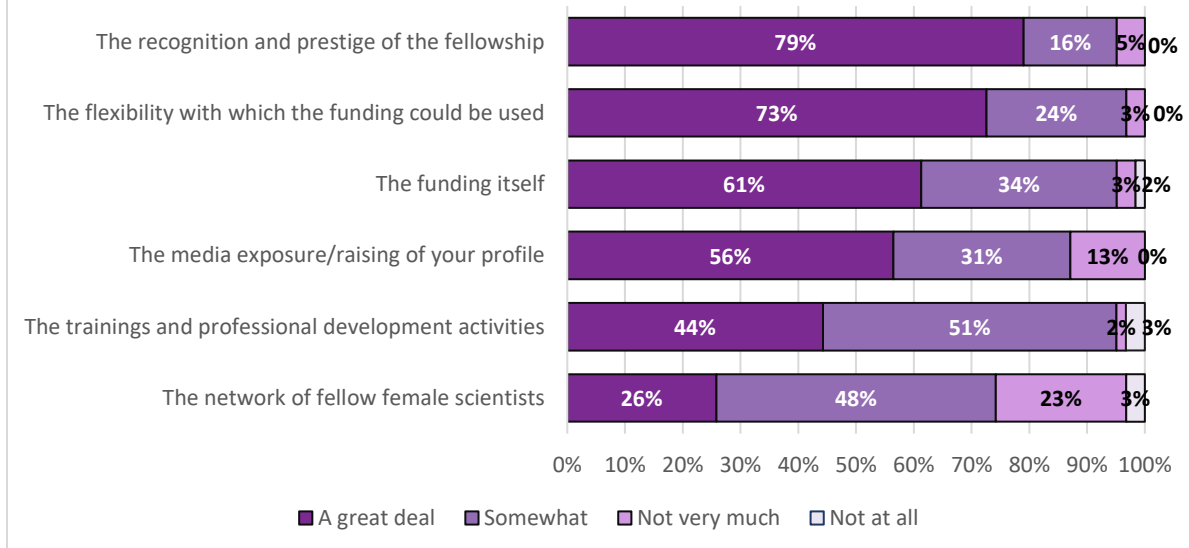
Exhibit 19. How FWIS Funding Was Used by Fellows (# of fellows)



Most Helpful Components of FWIS

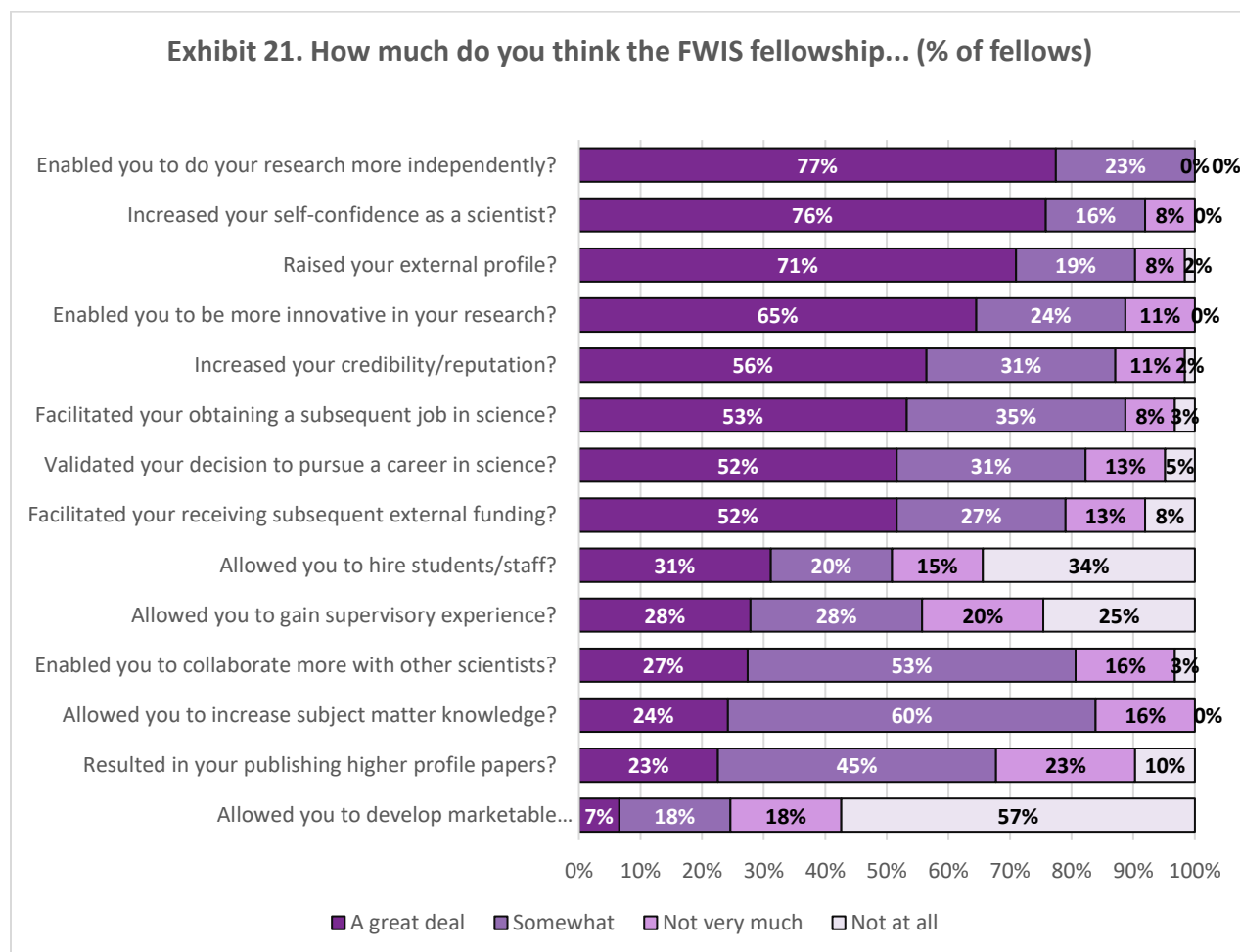
When asked about the extent to which various components of the FWIS program had helped the fellows in their careers, the two most helpful components were the recognition and prestige of the fellowship (which 79% of fellows felt had helped them “a great deal”) and the flexibility with which the funding could be used (which 73% felt had helped them “a great deal”). All components listed in Exhibit 20 were perceived as at least “somewhat” helpful to fellows’ careers. Other helpful components noted by fellows through an open-ended response option included the connection to other L’Oréal programs, such as the FWIS international program awards for postdocs and the later career Laureates.

Exhibit 20. How helpful has each of the following FWIS components been to your career? (% of fellows)

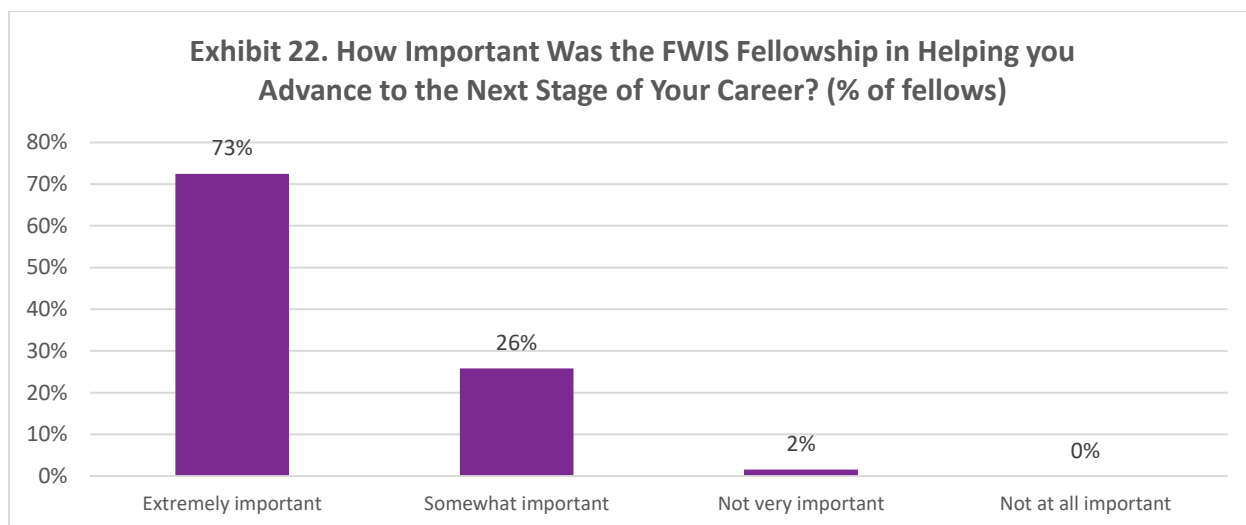


Perceived Impact on Professional and Personal Development

Fellows’ perceptions of the extent to which the FWIS fellowship had impacted various aspects of their professional and personal development are shown in Exhibit 21. As evident from the exhibit, the three most significant impacts of FWIS were that it: 1) allowed the fellows the freedom to conduct their postdoctoral research more independently (77% of fellows felt the FWIS fellowship had helped them “a great deal” in this regard), 2) increased fellows’ self-confidence as scientists (76% of fellows felt the FWIS fellowship had helped them “a great deal” in this regard), and 3) raised fellows’ external profiles (71% of fellows felt the FWIS fellowship had helped them “a great deal” in this regard). Over half of fellows benefited “a great deal” from FWIS in several other personal and professional ways, including enabling them to be more innovative in their research, increasing their credibility and reputation within their institutions or fields, obtaining a subsequent job in science, and receiving subsequent external funding. Over half (52%) also felt that the fellowship validated their decisions to pursue a career in science a great deal. Less common benefits of FWIS were developing marketable products or technologies, publishing higher profile papers, increasing subject matter knowledge or learning new techniques, collaborating more with other scientists, gaining supervisory experience, and hiring students or staff that the fellows would not have been able to otherwise.



Overall, the vast majority of fellows (73%) felt that the FWIS fellowship was “extremely important” in helping them advance to the next stage of their careers (see Exhibit 22).



Insights on the Benefits of FWIS

The web survey and qualitative interviews also captured insights from fellows on how the FWIS fellowship had affected them personally. Fellows' responses provide additional context to the closed-ended survey questions on the value of specific FWIS components (Exhibit 20) and the manner in which the fellowship affected their professional and personal development (Exhibit 21).

Not surprisingly, given the prominence of this theme in other survey questions, the most common theme among both web survey and qualitative interview responses was that **the financial support of the FWIS fellowship allowed fellows greater flexibility to pursue their research independently**. Several fellows were able to move into new (tangential) areas of research that were distinct from those of their PIs and establish their own independent line of research. The independence and flexibility of FWIS funding made it possible for fellows to take the scientific risk of pursuing a new area of investigation or working at an intersection of two scientific fields. Fellows emphasized how impactful it was to have the freedom afforded by independent funding at the critical postdoctoral training stage. Some noted that having independent FWIS funding as postdocs advantaged them as applicants for their first permanent positions because they had already established their ability to secure their own research funds.

The funding provided by the FWIS fellowship allowed me to pursue an independent line of research within my postdoctoral lab, which was distinct from the work of my postdoctoral mentor... The early success of [that] project provided me with credentials to be competitive on the tenure track job market, which was particularly rough at the time for economic reasons. The research I started under the FWIS fellowship evolved into the scientific program of my own lab, the success of which, in turn, drove my recent tenure decision. Thus, receiving the FWIS fellowship had ramifications for my career 10 years down the road. It made all the difference at a critical point in my career trajectory. The impact of the award, in my case, can't be overstated. (Dr. Sara Aton, 2008 fellow)

The most important impact of the FWIS fellowship on me was giving me financial and intellectual independence to pursue my research at a key career stage. (Dr. Molly Schumer, 2017 fellow)

Independent funding has been critical for me at several early career stages to allow me to follow my own ideas—both practically and psychologically. The award helped validate that the ideas I had were worth pursuing and encouraged me to be creative. (Dr. Julie Simpson, 2005 fellow)

The most important benefit of the FWIS fellowship for me was allowing me to conduct independent research that was the foundation of my faculty research program. I am still working on questions that I started pursuing with support from the FWIS fellowship. (Dr. Joanna Kelley, 2012 fellow)

The FWIS fellowship allowed me flexibility to pursue additional ideas related but tangential to my research. These scientific adventures turned into my career path. Without FWIS I would not have had this level of flexibility. (Dr. Katie Brenner, 2014 fellow)

It's really rare and wonderful when you have funds that are designated for exploration, that allow you to choose the direction in which you are going and support work that might not be otherwise supported. As a student or as a trainee, you are essentially...tied to what your advisor has funds to support. And so, having that freedom [from FWIS] to pursue a direction at that early stage is really impactful. (Dr. Pardis Sabeti, 2004 fellow)

Postdoctoral training is about learning how to think independently and pursue your own ideas. But that's often very hard to do because sometimes your ideas are not aligned with your lab head's ideas. The only way that you can really go for your own ideas is to find the resources...It shows that you're able to acquire independent funding, which is a really key trait as a head of lab. My job is to secure grant funding, so if I have a record of securing independent funding during my postdoctoral training, then I'm essentially demonstrating to academic hiring committees that I have mastered that skill. (Dr. Shruti Naik, 2016 fellow)

I've had two informational interviews of positions that I will apply for and both of them have stated that the fact that I've established my own line of funding [through FWIS] makes me a really strong candidate. (Dr. Brecca Gaffney, 2018 fellow)

Having an independent funding stream allowed several fellows to travel or purchase equipment or supplies to which they would otherwise not have had access. These resources enhanced the quality of their research and their resulting scientific accomplishments.

The FWIS fellowship directly impacted my research by helping me pay for access to high-end instrumentation critical for my research, and by supporting my salary so that I could pursue the research questions I found most interesting. (Dr. Jennifer Laaser, 2014 fellow)

Providing the travel funds to accept invitations for invited talks at important conferences in international locations. I would not have been able to attend without the travel funds. Attendance and delivering the invited talks was of great professional benefit to me, as I was able to get exposure and build a reputation and a network. (Dr. Tiffany Santos, 2009 fellow)

With the fellowship money, I hired a technician who physically helped me do more experiments. I was also able to purchase reagents and supplies that I wouldn't have been able to otherwise. This allowed me to do riskier experiments because, without this money, I

wouldn't have been able to have access to those reagents. On a practical level, the money for me was very important in just doing the research to make the discovery. (Dr. Shruti Naik, 2016 fellow)

I was able to buy a piece of equipment and now...instead of sharing with a facility or others, I could really use that to accelerate and advance my research. (Dr. Livia Schiavinato Eberlin, 2014 fellow)

Some fellows also commented on the fact that having independent funding allowing them to hire whomever they wanted to support their postdoctoral research, which allowed them to gain experience as a supervisor and mentor.

The freedom with the funding meant I could hire whomever I wanted... I really established myself as a successful and supportive advisor to students. I think it played a big role (in addition to my enhanced publication record from work with the postdoc I hired with FWIS money) in my landing a tenure-track faculty job. (Dr. Sarah Ballard, 2015 fellow)

The award also provided me with a slice of independence within a research field that is quite hierarchical—I was able to hire my own technician and build a "mini-lab" within my academic setting. (Dr. Moriel Zelikowsky, 2016 fellow)

Several fellows articulated the benefits associated with having financial support for their postdoctoral positions for an additional year. This allowed these fellows to accomplish more during their postdoctoral training than they would have otherwise:

The FWIS fellowship provided me the funding to continue my postdoctoral position for an additional year...The extra year made me more competitive for jobs (I had taken two months of maternity leave which set me behind my peers) and thus allowed me not only to continue in the field, but also to get a highly sought-after next position...I use the Hubble Space Telescope and I get one shot a year to apply for that, and then a panel of experts in my field look at that and they say if this is one of the things we want to let Hubble do that year. If I don't get picked, then I don't get any data for that that year. Or a ground-based telescope, you get maybe two shots a year to get data on those... Having another year means an entire other shot at all of that. And so that was extremely helpful. (Dr. Sabrina Stierwalt, 2014 fellow)

Several fellows noted that this "time extension" allowed them to start families, take maternity leave, or demonstrate their productivity after having taken maternity leave.

The most important benefit of the FWIS Fellowship was the flexibility it allowed me in pursuing my research interests and professional goals during the transition from postdoc to faculty, all while becoming a mother. L'Oréal consistently supported my desire to extend the timeline of my fellowship after having a baby and allowed me to rebudget multiple times. Having that "seed" money while becoming both a faculty member and mother was amazing. (Dr. Julie Huber, 2007 fellow)

In postdoc, you're around the age where a lot of people are starting families and, at least in the United States, the way you deal with the maternity leave is you pretend it never

happened. You don't put that break on your resume or your CV...and you just try to be extra productive while pregnant or with a newborn, in order to hide the fact that you took that break, which is just impossible...In fact, you often get the advice that it's better not to talk about having children because people look at you and think, "Well, do we want to hire this person? Because she's going to go on maternity leave. She's like around that age, or whatever." I know that in interviews I never talked to about having children or...being married or anything like that, which is sad. I'm not saying that's the way it should be, but I think that especially having this fellowship post maternity leave, it gave me some of that extra time back. (Dr. Sabrina Stierwalt, 2014 fellow)

In addition to the financial stability and benefits associated with the fellowship, many fellows noted the **increased confidence that resulted from the award**. Respondents described receiving the FWIS fellowship as a validating experience. The fact of being selected, and even the process of developing their FWIS applications and going through peer review of their proposed work, increased many fellows' confidence in their choice of career and their credibility to others at a critical time in their careers.

Regarding timing, I was transitioning into my second postdoc, and generally feeling disheartened and small. Winning the FWIS lifted my confidence so much—I got to enter my new workplace with this flashy prize (and they made announcements about it!) and felt that the external validation it provided made me feel like my presence in my field was important. The ceremony helped with this too, and getting to go to the White House...I just felt like I mattered, and I was struggling to feel that way in my field. (Dr. Sarah Ballard, 2015 fellow)

Being awarded a FWIS fellowship gave me confidence that I ranked highly among my peers and led me to more seriously consider staying in academic science (which I ultimately did). (Dr. Anne Carpenter, 2006 fellow)

The FWIS fellowship really gave me the validation and confidence that I needed to move forward in my career. I always wanted to be in academia but suffer from a lack of self-confidence that I don't think is unique to me, but is a major problem for many women in science. Being recognized among other successful young scientists validated my choice to pursue this career (Dr. Amber Alhadeff, 2018)

This is not just a check that's given to you...It's given to you with a sense of responsibility, a sense of connection, of purpose...The training period is isolating, and so much of the scientific practice is experiencing one failure after another...You just need that one person to believe in you, and having an organization like L'Oréal believe in me was very impactful. (Dr. Pardis Sabeti, 2004 fellow)

In discussing the manner in which the fellowship bolstered their confidence and reaffirmed their contributions and roles as scientists, it was clear that for several fellows, the FWIS fellowship was extremely influential in allowing them to remain in science. Again, the timing of the fellowship was critical for these early career scientists who were, in many cases, new mothers as well.

I think the odds were about 50/50 that I'd have left the field without FWIS—it boosted my confidence, it boosted my profile, and I got to see in concrete terms how I could use my position to pay it forward. (Dr. Sarah Ballard, 2015 fellow)

The prestige of the fellowship meant that not only did many fellows experience an increase in confidence and internal validation, but they also saw their **professional profiles elevated**. Fellows noted that L’Oreal’s publicity work on the fellows’ behalf, and the growing national reputation or “brand” of the fellowship, boosted fellows’ early-career efforts to establish their own scientific reputations. Being a FWIS fellow opened doors to coveted job opportunities because it demonstrated competence and served as a major distinguishing factor among prestigious candidates.

In the extremely competitive academic market, evidence that other scientists value your work is critical to getting jobs. Because FWIS is recognized as [a] mark of excellence in addition to providing funding, it carries weight in this evaluation. I believe this award made a difference in finding a job later. (Dr. Nozomi Nishimura, 2009 fellow)

The FWIS fellowship has raised my profile in my field. I have little doubt that it contributed to the job opportunities that were made available to me in academia, national labs, and industry. (Dr. Sydney Schreppler, 2017 fellow)

It...signified to senior researchers in and beyond my field that I am a competent scientist. (Dr. Erin Marie Williams-Hatala, 2012 fellow)

For me, it wasn't really even cash that made the most difference, but having that platform and visibility to the point where people in my institution would immediately know like, "Oh, she's received this award and it's really prestigious." And, you know, it really brings that level of assurance to people that you are deserving of this honor...it's a certification that you are really talented as a scientist and that your research is relevant. (Dr. Livia Schiavinato Eberlin, 2014 fellow)

Some fellows noted that their success and elevated profiles **allowed them to represent and raise the profile of women and girls in science**.

Recognition for enhanced discovery and earth science research, and the importance of leading the participation in science in an inclusive and diverse way that significantly raises the profile and participation of women and girls across all stages. (Dr. Anela Choy, 2016 fellow)

Finally, some survey and qualitative interview respondents commented on the value of the **networking opportunities available through FWIS**, which allowed fellows to support and mentor one another. The FWIS alumnae network provided fellows with a lasting personal network of women scientists around the country and remains a key source of peer-to-peer career advice.

It is critically important to encourage and empower young women in science, to help them see themselves as leaders in their field, and to connect them to other young women using innovation as a force for positive social change. This is what the FWIS fellowship provides: financial support to pursue impactful research on your own terms, and a supportive community of peers and mentors who help you build a strong brand as an innovator and role model. (Dr. Ritu Raman, 2017 fellow)

The interactions that the fellowship facilitated with other members of the scientific and nonscientific community helped me develop skills to communicate my research in an

effective way. This has been helpful in many ways, including speaking to the media and the public about my work. (Dr. Amber Alhadeff, 2018 fellow)

I felt part of something bigger than just me or my science. (Dr. Anne McNeil, 2006 fellow)

I still talk to all of them, and we give each other career advice, too... We come from different fields, so it's more about just being a woman or a mother in academia and relating on that level. It's really nice. (Dr. Sabrina Stierwalt, 2014 fellow)

Meeting other scientists, especially in...a broad range of fields, was great to get exposure to diverse perspectives. A biologist and a physicist, while we're both scientists, the cultures of our fields are very, very different. The challenges that women face in each of these fields are very, very different. Having a broader perspective is really important in informing how we need to change our institutions at the highest levels to support women in these different cultural microcosms. Another aspect of the fellowship I greatly appreciated was the sisterhood, and connecting with other women are brilliant scientists, really engaged, changing the world. Hearing their stories and journeys and supporting each other through our job searches. I'm still in touch with many fellows in my class and also classes above me and below me. I think that having a network gives you the social capital in the long run that you need to have a sustainable career. (Dr. Shruti Naik, 2016 fellow)

How FWIS Funding Shaped a Scientific Career: FWIS Fellow Sara Aton



Image credit: University of Michigan

Dr. Sara Aton, Associate Professor of Neuroscience and Associate Director of the Neuroscience Graduate Program in the University of Michigan School of Medicine, describes how having FWIS funding as a postdoc laid the foundation for long-term scientific engagement and productivity.

I was able to liberate my time and my intellectual effort and also invest in a little bit of technology in order to realize some new technical skills that really were kind of rare at the time...I think having that liberty to take a risk and actually fail before you succeed is something that in retrospect I realize is ... the most precious gift you can really get in science: the liberty to take risks and fail and spend some time actually failing and figuring things out, so that eventually you can succeed. If I hadn't had that, I don't think I'd be sitting here talking to you today from my office. I don't think I would have this job, given the hiring climate of the time and given the other resources that I had available, I think this one fellowship really was the thing that [made me] able to move ahead in my career at that point.

Building Personal and Scientific Confidence: FWIS Fellow Brecca Gaffney



Image credit: L'Oreal USA

Dr. Brecca Gaffney, a mechanical engineer and postdoctoral fellow in the Program in Physical Therapy at Washington University School of Medicine in St. Louis, explains how the FWIS program boosted her confidence as an early-career researcher.

I think we all have imposter syndrome. It's just whether or not we admit it... I've always had ideas of my own yet always second guessed their novelty. As a postdoc, I'm now at a place where I can start to pursue those more...[FWIS] was the first grant that I've gotten on my own, for my own idea. And so, it...really just gave me the validation I needed that my science is good science. It really gave me more confidence than I had before.

Communicating Scientific Discoveries to the Public: FWIS Fellow Sabrina Stierwalt



Image credit: Dan Addison

Dr. Sabrina Stierwalt, an Assistant Professor of Physics at Occidental College, puts the FWIS media training to use in bringing her research to a wide lay audience.

It's sort of like a snowball effect. Once you do one interview, other people, other journalists see that and then they want interviews as well...in the media training, they help you understand what [journalists are] really after, and are you getting your points across, because the journalist doesn't always know the right questions to ask you because they don't know your science. You might have this really interesting tidbit that they don't know to ask for...I find that form of communication [to the public] especially important. I mean, people pay tax money to NASA to build these telescopes, so they belong to everyone, and so I think we have a responsibility to communicate that information. This is what we're finding, this is why it's significant. This is what it tells us about where we come from and our planet, and the media training helped me with that...The Wall Street Journal, they named one of my [discoveries among the] "Top Five Things You Should Know Today" on the day Donald Trump was inaugurated as President.

Implications of Study Findings for Policy

This study was undertaken to identify factors critical to FWIS fellows' success to further the national dialogue around the underrepresentation of women in STEM, and ultimately contribute to policy and programmatic solutions aiming to address this gap. With a specific focus on the postdoctoral training stage—a transition point at which attrition for women in STEM fields is high—this study makes a unique contribution to the research literature on the experiences of women postdoctoral trainees in STEM fields and promising interventions for improving retention at this critical stage.

The experiences and insights of FWIS fellows offer important perspective on these broadly important issues for several reasons. FWIS fellows are not representative of the “typical” postdoctoral woman (given that they had already demonstrated exceptional aptitude at the time they were selected for the fellowship and, from the point of selection onward, benefited from the financial and other supports provided through FWIS, which minimized barriers that many women encounter during this stage of training and further increased their likelihood of success). Yet the fellows still struggled with many of the challenges facing other women postdoctoral trainees in male-dominated fields. Over half of FWIS fellows indicated that self-doubt or lack of confidence served as an obstacle to their career trajectories during their postdoctoral training, with many also struggling with the lack of female role models or mentors available to them. Even among the highly select group of FWIS fellows, some were indeed vulnerable to attrition: As evident from the open-ended web survey responses and qualitative interviews, several fellows indicated that they had been considering leaving science or were on the verge of leaving (due to a host of challenges) if it were not for the FWIS fellowship.

Second, even though the fellows may have been protected from some of the key challenges facing women postdocs generally, their active role in training and mentoring the next generation of scientists has allowed them to develop a broad perspective on the challenges and needed supports among women postdocs generally. As described in this report, the FWIS fellows have supervised, managed, or mentored over 1,500 scientists, including 319 graduate students and 227 postdocs or other PhD level scientists. Therefore, the FWIS fellows, who represent over 20 scientific disciplines, have a unique understanding of what interventions and policy changes could actually make a difference in improving retention for women at this critical stage of training.

Findings from this study reinforce prior research on the need for intervention to better support women during their postdoctoral training. Despite some improvements for women in science, including modest gains in the representation of women in STEM fields, fellows felt that gender discrimination remained a career obstacle for women in science and that women entering their fields are not given equal opportunities relative to their male colleagues. The qualitative interviews identified several ways in which gender bias in science is persistent and pervasive, which indicates the need for policies, structured supports, and formal interventions, as well as efforts targeted toward improving the climate for women in science.

This study points to several specific areas for intervention. First, it clearly highlights the need for, and value of, independent funding for women scientists at the postdoctoral stage. Having received independent funding was the most important career facilitator for FWIS fellows during their postdoctoral training. This was the factor to which fellows most often attributed their success. They articulated numerous ways that having independent funding allowed them to not just remain “academically alive” during this period but to thrive scientifically at an early stage in their careers by

establishing an independent line of research that served as the foundation for their careers. Independent grant funding for postdoctoral scientists was also the primary intervention that fellows felt would be effective in promoting career advancement among women postdocs generally. Therefore, universities, private corporations, professional associations, foundations, and federal funding agencies should seek to develop more mechanisms that provide independent funding to women postdoctoral scientists. The current funding opportunities for postdoctoral trainees are extremely limited, and study findings suggest that investments during the postdoctoral training stage could have large impacts for the retention of women in science, particularly in the academic career trajectory. Ideally, grants for postdocs would have the degree of flexibility afforded by FWIS and be accompanied by additional supports that reduce women's sense of isolation and promote their achievements, such as networking opportunities among recipients and profile-raising activities.

Second, echoing recommendations made in a number of other studies, this study indicates the need for structured family supports and family-friendly policies specifically targeted to postdoctoral trainees. Fellows identified family constraints or responsibilities as one of the top barriers to women's career trajectories during the postdoctoral training and felt that family-friendly policies and supports would be highly effective in promoting women's career advancement in the postdoctoral stage. As discussed in the qualitative interviews, the climate in many scientific fields is unsupportive of parenting in a number of ways. Not only are specific interventions needed, particularly paid family leave and affordable, high-quality childcare, but efforts to make the culture within labs and departments more family-friendly could allow more women to feel that it is possible to be a mother and have a successful career in science, as opposed to choosing one or the other.

Third, the need for improvements in mentoring and networking opportunities available for women in science is affirmed by this study. Many fellows felt that they would have benefited tremendously from having had a female mentor (or having more women in leadership positions in their professional networks). The small number who did have female mentors spoke about the pivotal role of these role models in their careers. In addition to the need for more female mentors, improvements in mentoring generally, are suggested by the study findings. Efforts to provide more structured training and accountability for PIs as mentors and managers—not just as scientists—could enhance the quality of postdoctoral training for both women and men. Given the pivotal role of mentorship during this career stage, improvements in this process could improve retention for trainees and promote successful transitions into both academic and nonacademic permanent positions.

Finally, strategies to address the confidence gap among women in science are needed. The fact that self-doubt and lack of confidence threatened the career trajectories of such a highly select and exceptionally competent group of scientists is alarming, given the consequences of lack of confidence for long-term scientific contributions (e.g., lack of self-promotion, hesitancy in applying for leadership positions, attrition from science). Not all women postdocs can receive an award that increases their confidence and validates their decision to stay in science; however, efforts to showcase the achievements of women postdocs could have a similar impact. Scientific and professional societies should make a concerted effort to promote the work of female scientists through awards, dedicated networking opportunities, and dedicated journal features on the work of female and minority scientists.