NIGMS Analysis of Supplements to Enhance Diversity 1989-2006

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May 28, 2015

Abstract

As part of an National Institutes of Health (NIH)-wide program, principal investigators holding NIGMS research grants may request supplemental funds to improve the diversity of the research workforce by supporting and recruiting students and postdoctoral fellows from underrepresented racial and ethnic groups, individuals with disabilities and individuals from disadvantaged backgrounds (described here as the Diversity Supplement Program, or DSP). The purpose of this analysis was to identify the subsequent training and career outcomes of individuals who had been supported by DSP funds. This project focused on NIGMS supplements awarded between 1989-2006, a period that allowed awardees to complete their training and embark on post-training careers. Educational and occupational outcome data were largely available in public sources, but required important data validation and cleaning approaches to manage the quality of self-reported information. This analysis demonstrated excellent Ph.D. completion rates among NIGMS-DSP graduate awardees, consistent with completion outcomes in other well-funded programs in research-rich environments. Review of the doctoral-granting institutions suggest that most Ph.D.s were earned at research-intensive institutions, and that the DSP may offer a previously unrecognized role in "entry or re-entry" to research-intensive institutions for postdoctoral trainees. The project also revealed that the majority of supplement awardees chose research and research-leadership careers in multiple sectors important to the U.S. biomedical research workforce.

Introduction

NIGMS participates in the NIH-wide Supplements to Promote Diversity in Health-Related Research (PA-12-149; reference 1) funding opportunity designed to support research experiences for individuals from groups underrepresented in biomedical science. The supplement goals are to support those who wish to develop research capabilities and participate in career development experiences, and to diversify the biomedical workforce. The approach is to provide an administrative supplement to the original research grant to support research and career development.

Principal investigators at domestic institutions who have an active NIGMS research grant, program project grant, center grant or cooperative agreement research program with a reasonable period of research support remaining at the time of the supplemental award are eligible to submit a request to NIGMS for an administrative diversity supplement to the grant. Typically a grant will have at least 2 years remaining to support a supplement for a graduate student or postdoctoral fellow, and the brief application from the Principal Investigator includes not only a research plan describing the advances the awardee can contribute by joining the research, but also a mentoring and training plan, which should assess the awardee's capabilities and identify specific training goals designed for the awardee.

Participant eligibility was determined by awardee institutions and conforms to the NIH's Interest in Diversity, although specific eligibility requirements may have changed over the history of these awards. Current eligibility focuses on individuals from groups underrepresented in biomedical sciences identified by the National Science Foundation report, "Women, Minorities and Persons with Disabilities in Science and Engineering" 2015; references 2, 3) and generally includes individuals from select racial and ethnic groups, individuals with disabilities, and individuals from disadvantaged groups at the undergraduate levels (for details, see NOT-OD-15-053, January 12, 2015, reference 4).

The current Funding Opportunity Announcement states that "continuation of this program in the future will depend on evaluation of the career outcomes…" To comply with the evaluation goal in the funding announcement, and to better understand the potential impact of these awards, NIGMS performed this DSP participant outcome analysis.

Methods

Transcribe and Collate DSP Award Information. As an administrative supplement, materials associated with the award have not historically been collected as structured data at NIGMS. In the past, a supplement request was submitted as a paper application, and following staff review, an additional paper-based staff recommendation summary was prepared and attached to the application. In 2014, a transition to accepting similar applications electronically was made. Folders including these files were used to collect information on the parent grant award as well as the awardee's educational history, for the period 1989-2006. While NIGMS supplement awards have been made for awardees at various career stages, the focus of this evaluation was limited to individuals who were supported as an undergraduate, a graduate student or as a postdoctoral fellow (Figure 1).

Outcome Measures. Key outcome indicators included A.) Educational measures including the terminal earned degree, year of degree and institution from which the degree was earned, as well as B.) Career outcome measures including the job title, career institution or organization, and the geographic state in which the work was carried out.

Public Information Data Mining Approach and Limitations. The approach was to probe public sources for information on the awardees, using general information from the supplement application on the individuals' educational history (for example, the awardee earned a baccalaureate degree at institution X, and was performing the supplement-supported graduate research at institution Y, during the specified years of the award). A number of sources were probed for educational and professional information, including Google, Linked In, Scopus, Ph.D. Tree, NIH Reporter, Intellius, patent information and institutional links with information about alumni. These public sources are widely considered networks for professional interactions; by contrast, Facebook was deliberately avoided, as it is often used for personal networks.

It is important to note that public searches by definition provide self-reported information, and that poses distinct challenges both for data quality and data structure. Individuals or institutions may provide information that is inaccurate in small (incorrect year of degree award) or large ways (did not earn a degree at all). In an attempt to account for such inconsistencies, data confirmed from multiple sources were preferred over single entries, and some sources were considered higher quality than others (for example, an electronic dissertation was higher quality than an alumni Web site). There were a number of variations in names including middle names or initials or nicknames that were often easily resolved. There was often less information about an awardee who earned a degree in the early 1990s when Internet use was just becoming common, than today, when dissertations are often available online. For the most part, these concerns affected whether an outcome might be found readily. An important qualification about this analysis, however, is in the reporting of university names when the school is known to have multiple campuses. Campus information was collected when reported, but if no campus designation was provided, the main campus was assumed for this analysis. The ambiguous campus name and this potential misclassification error may be large enough to reduce confidence in some analyses, as noted. Fuzzy lookup tools that measure text similarity were used to match institution names with lists of Carnegie Classification and minority-serving institutions.

The terminal degree (e.g., M.D. or Ph.D.) and year of conferral proved to be a powerful identifier over time. A key quality step in this analysis was to confirm only educational outcomes for which there was both a degree and a year reported. For any stated "Ph.D." but no year available, the educational outcome remained as "unknown." For this reason, the educational outcomes may be slightly under-reported.

A last concern is that some of the information might not be current. Because public information often lacks a timestamp indicating the posting date by individuals and institutions, some data, including the current job, are basically a snapshot for an awardee.

Results and Discussion

In light of the lengthy training period typical in the sciences to prepare for a biomedical research career, this project was limited to NIGMS awards between 1989-2006. For example, a graduate student supported in the first year in 2006 might be modeled to complete a Ph.D. in 6 years, followed perhaps by a 4-7 year postdoctoral experience before embarking upon an independent career. Indeed, there were more individuals classified as "in training" in the more recent years of the project period, as well as several retirements from the early years of the project period.

Degree Attainment. For graduate students supported by an NIGMS-DSP award, Ph.D. degree attainment was 72.8 percent (Figure 2). For this analysis of all graduate students, we were unable to confirm a degree for about 19 percent of awardees. Some of these unknowns may have a degree, but did not satisfy our "degree plus degree date" criteria. For that reason, it is important to recognize that *at least* 73 percent of DSP graduate students earned the Ph.D.

The high level of Ph.D. completion by awardees supported by the NIGMS DSP bears discussion. In any program, not every enrolled Ph.D. student completes the degree, and some students exit the program with an M.S. or leave without a degree at all. In life sciences fields, the completion of a Ph.D. varies by discipline, but hovers about 65-70 percent (Council of Graduate Schools Completion and Attrition Program, 2008, reference 5). The recent report from Council of Graduate Schools (DIMAC 2015, reference 6) indicates that students from underrepresented groups completed a life science Ph.D. at a lower rate of about 50-58 percent. NIH-wide Ph.D. completion by trainees supported by the predoctoral NRSA programs was 79.4 percent in FY2012 (including institutional training programs as well as fellowships; OER report, September 2014, reference 7).

It is perhaps not a surprise that Ph.D. completion is high among graduate awardees, given the context of a successful supplemental application. Because the award is a supplement to an active research program, the awardee is engaged in high-quality research at an institution with a strong research environment and support. In addition, the principal investigator and awardee emphasize the training value and the mentoring plan for the proposed supplement, ensuring some level of engagement and support. The graduate student applicant is already accepted into the graduate institution before the award is made, removing that potential barrier. In a sense, the diversity supplement program is not really an "institutional program" at all as it does not require much institutional support, but the DSP might set the bar that such institutional training programs are expected to exceed.

The vast majority (85 percent) of postdoctoral participants earned a Ph.D. degree before the DSP award was made. Because the degree was reported in the application for postdoctorates, there was far less uncertainty (but not zero) about this confirmed terminal degree.

Undergraduates, however, were far more difficult to trace to a terminal degree. In this analysis, at least 16 percent earned a Ph.D., and at least 31 percent earned an M.D., but, even after considerable effort, a third of undergraduates remained "unknown" for their terminal degree. In part, this may reflect less reliance on reporting a terminal baccalaureate in a typical job resume, so that the baccalaureate award itself was difficult to confirm.

In addition, the short duration of a typical undergraduate DSP award may limit its impact. Many undergraduate DSP awardees performed research at another institution for one or more summer experiences, while a smaller number were supported for year-long research at the student's home institution. While summer programs have benefits for student confidence and skills, it is less clear what impact the research experience has on the choice of career (Lopatto 2006, reference 8). These short-term awards may be associated with a student who wishes to "test out" a research environment or project. The resulting experience may have built a student's confidence that research was the right—or the wrong—choice for further study.

Career Outcomes. Job titles were mapped to the career sectors reported for U.S.-trained Ph.D.s in the Advisory Committee of the Director/Biomedical Workforce Report (2012, reference 9). That report, also based on self-reported occupations, characterized positions in which the individual had direct contact with research as "Research" and others as "Non-Research," while acknowledging that "Non-Research" leaders and managers play important roles in the research enterprise. Using general information from that report, as well as more specific criteria (Figure 3), the career sectors of participants supported by the DSP were codified.

An overall comparison of the career sectors for graduate students and postdocs supported by the NIGMS DSP with those reported for the U.S.-trained Ph.D. workforce as a whole shows that DSP awardees are in similar career sectors (Figure 4). A large proportion of post-training careers by awardees were in academic research/teaching, as well as industry and government research. Careers in research were the most prevalent outcome throughout the study. About 65 percent of DSP supported graduate students and postdocs were in research careers (including academia, industry and government research). Indeed, this research outcome was seen in each of the 5-year cohorts of the study. A number of NIGMS DSP awardees had research and leadership career outcomes in biotechnology and pharmaceutical applications in industry research, perhaps reflecting the NIGMS mission not only fundamental, interdisciplinary research in the life sciences, but also in several fields of chemistry. While subsequent research grant applications and awards can be used to measure successful outcomes, it remains important to recognize that in only one career sector—academic research and teaching—are such outcomes a meaningful measure. For this reason, it is important to identify the multiple career sector outcomes from our trainees that contribute to a vibrant biomedical research workforce.

Consistent with these data, recent trends suggest that the doctoral academic science and engineering workforce shifted between 2008 and 2010, with a decline in science and engineering doctorate holders employed in academia, and an increase across various other sectors of the economy (NSF Science and Engineering Indicators, 2014; Chapter 5, reference 10).

Where the Ph.D. Is Earned. To understand better the institutions in which students earned the Ph.D., the degree institutions were compared with their Carnegie Classification (Figure 5). The Carnegie Classification of Institutions of Higher Education Basic 2010 (reference 11) provides a framework to understand comparable colleges and universities in the United States. The majority of NIGMS DSP graduate students earned the Ph.D. at research universities, which might be anticipated, as their

supplement rested in part upon an active research award. Many DSP postdocs had earlier earned a Ph.D. at research-intensive institutions, but also at doctoral research universities.

Universities with significant diversity in student enrollment are recognized as "minority-serving" with eligibility for some federal funding. An important group of minority-serving institutions are the 106 Historically Black Colleges and Universities (HBCUs) that were established with the intention of serving the black community. In addition, the Department of Education recognizes institutions with significant enrollment of Hispanics as Hispanic-Serving Institutions (HSIs). A second analysis of the Ph.D.-granting institutions at which NIGMS DSP awardees earned (or postdocs had earned) the research doctorate suggests that more postdocs than graduate students earned their Ph.D. from a minority-serving institution (Figure 6; Chi-Square p=0.001). This could mean that the DSP offers postdocs an opportunity to enter or re-enter research-intensive institutions for further training.

Support for the remainder of the participant's training is likely derived from multiple sources including training mechanisms, fellowships, as well as research grants. NIGMS encourages subsequent nomination to an institution's T32 predoctoral training grant, if any, or individual fellowship awards. Within NIGMS, a very small number of awardees earned support from the DSP for multiple career steps (i.e., both graduate and postdoctoral DSP support), but current information and reporting systems make it difficult to trace the support of each awardee throughout their educational experiences.

Impact on the U.S. Biomedical Workforce. The multiple biomedical careers undertaken by NIGMS DSP awardees help to fuel the US economy and specifically, the research that leads to advances in health and medicine. Scientific careers employ workers in universities and companies, and engage scientists-in-training. The scientific enterprise impacts vendors for equipment and supplies, and provides high quality jobs important to communities and the U.S. (Figure 7). Biomedical careers contribute to knowledge and innovation, application and communication about science.

Conclusions from the NIGMS DSP Analysis, 2014

1. Educational and career outcome data were largely available in public sources. The project required the identification of multiple data sources as well as validation and cleaning approaches. Improved long-term outcome reporting is warranted in light of extended training periods in biomedical science. The terminal degree serves as a powerful identifier for participants over time.
2. Ph.D. degree completion is high among DSP participants:
    a. NIGMS DSP graduate students have strong Ph.D. completion rates.
    b. Undergraduates in the NIGMS DSP may be more likely to complete a medical degree than a graduate degree.
    c. Postdocs came from a broader range of Ph.D. institutions than graduate students.
3. Comparison with national trends in career outcomes is useful:
    a. NIGMS DSP graduate students and postdocs have largely research outcomes.
    b. Research grant application/awards are important measures only for a small proportion of Ph.D. scientists in academic/research career sectors.
4. Understanding the career outcomes from training programs helps to describe their impact and contribution to the biomedical workforce:

a. The NIGMS DSP contributes to a vibrant biomedical research workforce in multiple careers in many states.

Related References

1. Research Supplements to Promote Diversity in Health-Related Research (Administrative Supplement) PA-12-149, posted April 6, 2012

2. Women, Minorities and Persons with Disabilities in Science and Engineering 2015, http://www.nsf.gov/statistics/2015/nsf15311/digest

3. National Science Foundation data on underrepresentation in health-related sciences on a national basis (data at http://www.nsf.gov/statistics/showpub.cfm?TopID=2&SubID=27)

4. Notice of NIH's Interest in Diversity NOT-OD-15-053, January 12, 2015

5. Completion and Attrition: Analysis of Baseline Demographic Data from the Ph.D. Completion Project. Council of Graduate Schools, 2008. Table 6: Cumulative Completion Rates by Programs, by Broad Field-Life Science, http://www.phdcompletion.org/quantitative/book1_quant.asp

6. Doctoral Initiative on Minority Attrition and Completion (DIMAC), 2015, Council of Graduate Schools

7. Characteristics of NRSA Recipients, Office of Extramural Research presentation, September 2014

8. Lopatto, D (2007) Undergraduate research experiences support science career decisions and active learning. CBE-Life Sciences Education 6:297-306

9. Advisory Committee to the Director, Biomedical Workforce Report, 2012 http://acd.od.nih.gov/Biomedical_research_wgreport.pdf and http://report.nih.gov/investigators_and_trainees/ACD_BWF/index.aspx

10. Science and Engineering Indicators, National Science Foundation 2014; Chapter 5. Academic Research and Development, http://www.nsf.gov/statistics/seind14/index.cfm/chapter-5/c5h.htm

11. The Carnegie Classification of Institutions of Higher Education Basic 2010, http://carnegieclassifications.iu.edu

12. Minority-serving institutions described at http://www.dhs.gov/sites/default/files/publications/fy-2013-white-house-initiatives-report-on-executive-msi-actions.pdf

Career Stage	1989/90	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total Awards
Graduate Student	43	50	26	33	27	51	43	45	38	32	44	36	55	59	71	51	85	**789**
Postdoc	11	19	17	23	24	22	24	21	21	28	22	12	17	27	28	36	25	**377**
Undergraduate	25	40	30	30	21	37	30	22	18	17	5	19	16	19	21	20	17	**387**

Figure 1. NIGMS DSP awards, 1989-2006. While NIGMS supports supplement awards at various career stages, the focus of this evaluation was limited to individuals who were supported as an undergraduate, graduate student, or postdoctoral fellow. The table reflects awards per fiscal year, and may include more than one award to an individual (for example, an extension appears as another award). For most subsequent analyses, the awards were resolved to unique individuals.

	Undergraduates		Graduate Students		Postdocs
Degree Type	Count	Percent	Count	Percent	Percent
Ph.D. equivalent[#]	59	16.1%	500	72.8%	85%
Master[&]	19	5.2%	36	5.2%	0
Medical[+]	112	30.5%	22	3.2%	12.1%
Bachelor^	49	13.4%		*	0
Other	*	*	0	0	0
Unknown	125	34.1%	128	18.6%	2.9%
Grand Total	(367)	100%	(687)	100%	(306)

Figure 2. NIGMS DSP Educational Outcomes. The number and percentage of unique DSP awardees who earned various terminal degrees, and the percentage of terminal degrees previously obtained by postdocs are shown. Only degrees for which both the date and degree type were known are included (for example, a Ph.D. but no date remains as "unknown). Multiple degrees are included in each degree type, as follows: Ph.D. equivalent[#] Ph.D., M.D./Ph.D., Pharm.D., Master[&] including M.S., M.A., M.P.H., M.B.A., M.P.T.; Medical[+] including M.D., D.O., D.D.S., D.V.M, O.D.; and Bachelor^ including B.S., B.A., B.S.E.E. "Other" includes a variety of other degrees or certificate awards. (*) indicates cases that include fewer than 1 percent of awardees.

	Career Sector	Example of Job Title
In training	In training	medical student, medical resident, postdoctoral fellow, trainee
Research	Academic Research Teaching	instructor, assistant professor, associate professor, professor, staff scientist, technician, faculty; at community college, college, university, medical school
	Government Research	researcher, scientist; at federal lab
	Industrial Research	discovery or preclinical researcher in non-academic setting; scientist, chemist, engineer, technician, specialist, medical testing; lab analyst; at biotech or corporate company, private research institute
Science Related Non Research	Research Leader	director, head, manager, vice president, branch chief, program officer; at academic, government, or industry organization
	Health Professional	physician, dentist, pharmacist, clinical psychologist, ophthalmologist; at private practice or non-academic appointment
	Business of Science	management consultant, venture capitalist, entrepreneur; at science industry
	Research Regulation	patent attorney, patent agent, compliance officer, research administrator; dean or director of research program (only if not also faculty); attorney, patent agent, patent examiner
Non Science	Science Communication	K-12 teacher, specialist; public outreach at museum; public affairs, science or technical writer or journalist, editor
	Non-Science Related	stockbroker, civil engineer, sales and marketing

Figure 3. Job Titles and Corresponding Career Sectors. Examples of reported job titles and their mapping to various career sectors from the Advisory Committee to the Director Biomedical Workforce Report 2012 (reference 9) are shown.

Biomedical Workforce[1]	Career Sector	NIGMS DSP Grad with Ph.D.	NIGMS DSP Postdoc with Ph.D.
43%	Academic Research or Teaching	40.6%	45.0%
18%	Industry Research	17.6%	11.2%
6%	Government Research	3.4%	4.0%
18%	Science-Related Non Research	23.5%	22.3%
13%	Non-Science	4.1%	4.8%
2%	Unemployed/Deceased	1%	1%
	Unknown	9.8%	11.6%
2008; n=128,000		1989-2006 N =434	1989-2006 N=254

Figure 4. NIGMS Post-Training Outcomes from the DSP 1989-2006. Data on the U.S.-trained biomedical workforce is shown for comparison. [1] Advisory Committee to the Director Biomedical Workforce Report 2012 (reference 9)

Carnegie Classification of Institutions of Higher Education	%GS	%PD
Bac/A&S: Baccalaureate Colleges--Arts & Sciences	*	*
Bac/Diverse: Baccalaureate Colleges--Diverse Fields	*	*
DRU: Doctoral/Research Universities	*	**3.8**
Master's L: Master's Colleges and Universities (larger)	*	*
Master's M: Master's Colleges and Universities (medium)	*	*
RU/H: Research Universities (high research activity)	**3.6**	**11.2**
RU/VH: Research Universities (very high research activity)	**83.5**	**70.0**
Spec/Med: Special Focus Institutions--Medical schools, ctrs	**5.8**	**7.3**
Foreign Institution	*	**3.1**
Medical School (Not in Carnegie List)	**4.0**	**3.1**
No Assignment	**1.2**	**1.2**
Total	100.0	100.0

Figure 5. Research Institution Classification where Ph.D. was earned. * indicates cells with less than 1 percent.

Degree Institution		
Type of School	% GS	% PD
HBCU	*	5
TCU	*	*
AIANSI	4	7
H.S.I.	4	8
AANAPISI	5	5
PBI	*	*
Sum of MSI of all awardees	13	22**

Figure 6. The institutions at which NIGMS DSP awardees earned a research doctorate or PhD equivalent were summarized and rounded to whole percentages. While most students trained at non-minority-serving institutions, some earned their doctorate degrees at minority-serving institutions including HBCU Historically Black College and University; TCU Tribal College and University; AIANSI American Indian Alaska Native Serving Institutions; H.S.I. Hispanic-Serving Institutions; AANAPISI Asian American and Native American Pacific Islander-Serving Institutions; PBI Predominantly Black Institutions; (institutions may be in several of these categories, reference 12) The percentage of postdoc awardees who earned a Ph.D. at a "minority-serving institution" was almost twice that of graduate awardees (Chi-Squared, p=0.001).

** The total appears smaller than the sum of each institution type, as some institutions have multiple MSI designations. The total reflects the total number of minority serving institutions.

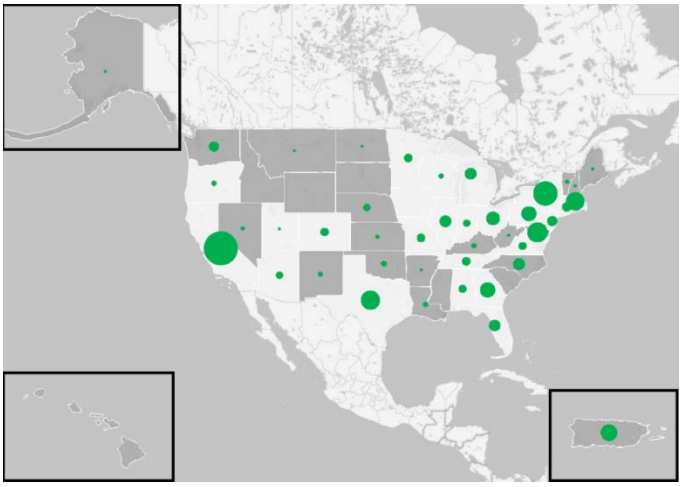

Figure 7. NIGMS DSP biomedical research careers have broad impact in the United States. Science endeavors employ workers in universities and companies across the nation and contribute knowledge and innovation that impact communities and states. The location of post-training jobs from all NIGMS DSP participants is shown, with the size of the dot related to number of participants.