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Enhancing diversity in the hematology biomedical research workforce: A mentoring program to improve the odds of career success for early stage investigators

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The necessity for greater racial and ethnic diversity in the US biomedical research workforce is evident, however many challenges must be overcome to achieve this formidable goal. Historically, underrepresented minority (URM) groups are the most rapidly growing segment of the US population and there is an urgent need to ensure that scientific talent among these groups is recognized, mentored and actively supported. For example, in 2010, Hispanics/Latinos, Blacks/African Americans, and American Indians/Alaskan Natives represented 29.8% of the US population, yet only 4.8% of National Institutes of Health (NIH) research project grants (RPG) were awarded to URM principal investigators.[1] A study by Ginther et al. revealed that PhD-trained African American applicants are 13.2% less likely than White applicants to be awarded RPG.[2] While the NIH is the largest research funding agency in the world, it has not achieved proportional representation of URM investigators in the US biomedical research workforce. Likewise, the imperative to increase diversity is justified by inequities in access to health care and health outcomes.[3]

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AUTHOR CONTRIBUTIONS

All authors contributed to PRIDE program design, mentee recruitment, mentoring and the development of didactic lectures and laboratory practicums. Evaluation tools were designed and data collected by the PRIDE Coordination Core; additional data were also collected and analyzed in the FTG-PRIDE Program office. All authors contributed to writing and revising the manuscript and are in agreement with all content.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

Improving these statistics will require interventions such as the introduction of innovative training models involving dedicated mentoring by established NIH-funded investigators, which are tested by rigorous evaluations. Analysis of the results from these training models will demonstrate the extent to which current interventions increase representation of URM groups in the biomedical research enterprise. Recently, the NIH established the National Research Mentoring Network (NRMN) to improve the success of URM investigators with the goal of diversifying our nation's biomedical research workforce.

There is a paucity of published data demonstrating that structured research mentoring programs promote grant funding, and professional development of early stage investigators (ESI).[4] To provide expanded mentoring support for URM investigators, in 2006 the National Heart, Lung, and Blood Institute (NHLBI) established the Summer Institute Program to Increase Diversity (SIPID), and subsequently the PRIDE (Program to Increase Diversity Among Individuals Engaged in Health-Related Research) Program. The scope of the PRIDE Program consists of seven academic sites, each focused on a specific research area. The objective of all programs is to provide intense research and career development mentorship coordinated through a central PRIDE Coordination Core (PCC) described recently.[5] The PRIDE Program at Augusta University is focused on "Functional and Translational Genomics of Blood Disorders" (FTG-PRIDE), and has been funded by NHLBI since 2006. During each funding period, 3 cohorts of 6–10 mentees were recruited after the FTG-PRIDE Admissions Committee reviewed and ranked applications. Top candidates were interviewed to ensure the program requirements were fulfilled and a suitable mentor-mentee dyad could be established.

While many approaches can be taken to address the inequity of URM representation in the US biomedical research workforce, the objectives of the PRIDE Program has principally focused on training ESI in grant writing skills to achieve extramural funding and expanded research-related technical skills. To evaluate program effectiveness, the PCC developed and administered a series of evaluation questionnaires during the 2-year training period and for 8 years after training completion. Mentee demographics and career development-related outcomes have been collected since 2006. To assess research self-efficacy, a 19-item Clinical Research Appraisal Inventory (CRAI-19) previously validated in the PRIDE Program,[6] is completed annually.

To accomplish these objectives, the FTG-PRIDE Program leadership organizes two consecutive Summer Institutes at Augusta University, each lasting 2 to 3 weeks. In addition, a mid-year face-to-face meeting is attended by each mentee with their primary mentor to review research progress, and to update skills and adopt new technologies. Mentees are also required to attend the National PRIDE Meeting convened annually in Bethesda, MD. The purpose of this meeting is to provide opportunities for trainees to interact with NHLBI program staff, present their research to other trainees, mentors and teaching faculty from all PRIDE programs, and establish research collaborations.

During the period 2006–2017, we trained 76 mentees in the FTG-PRIDE Program (Supporting Information Table S1) under Institutional Review Board approval and informed consent for data collection by the PCC. Since the last cohort of participants in PRIDE 2 has

not completed its second year of training, the data presented here are limited to the 48 mentees trained in SIPID and PRIDE 1. Of this group, 6 mentees were excluded from the analysis due to withdrawal from the program, matriculation into a second PRIDE Program, or noncompliance with program evaluations. As a result, the outcomes of 42 evaluable mentees are described in this report.

The design of the 2-year FTG-PRIDE Program is summarized in Supporting Information Figure S1. The first Summer Institute commences with a Welcome Ceremony attended by mentees, mentors, teaching faculty, and program leadership along with high-level administrators from Augusta University. After orientation to review program requirements, one-on-one mentee/mentor meetings are held to initiate the mentoring process. All mentees participated in a rigorous curriculum designed to enhance their research and grant writing skills. In addition, didactic lectures on genomics, translational and clinical research topics and laboratory practicums are completed.

To facilitate networking between different cohorts, we hold a 2-day overlap session for mentees actively training in the PRIDE Program (Supporting Information Figure S1). In addition, trainees interact with the NHLBI Program Officer to identify funding opportunities during a grant writing workshop. To conclude Summer Institute 1, mentees present their research projects to receive critical feedback and identify areas of common interests and collaboration. In the months following, mentees continue to fulfil required program activities including contacts with mentor, mid-year visit and attending the National PRIDE meeting. During Summer Institute 2, an innovative one-on-one grant review is conducted by NIH-funded investigators who travel to Augusta University to meet with assigned mentees, and develop a strategy to strengthen their research proposal and increase fundability. At the conclusion of Summer Institute 2, mentees receive a certificate of completion from NHLBI in recognition of meeting all program requirements.

During the period from 2006 to 2016, 42 mentees completed all requirements the SIPID and PRIDE 1 Programs. Because the scientific focus of the FTG-PRIDE program is related to blood disorders, 34 out of 42 mentees (81%) conducted hematology research; the remaining mentees' research focused on cardiology, microbiology, and diabetes. Given the high percentage of mentees conducting hematology research, the impact of the FTG-PRIDE Program within this subspecialty was analyzed.

Overwhelmingly, female investigators (76.5%) benefitted from this mentoring program, however the balance between MD (55.9%) and PhD (32.4%) trained investigators has remained steady over the years (Table 1). African Americans comprised 79.4% of mentees and held academic appointments at the rank of assistant professor (85.3%). The majority of mentees (91.2%) conduct sickle cell disease research involving clinical/translation studies to expand our knowledge of disease pathophysiology and to improve medical care. Despite recent national trends of 25% attrition rates among ESI from medical school faculty positions,[7] we observed academic promotion largely from assistant to associate professor for 9 out of 34 mentees. A 2011 survey conducted by the American Society of Pediatric Hematology/Oncology showed that 8.6% of its membership is from URM groups,[8] indicating a clear need to increase diversity within this medical subspecialty. To impact these

statistics, we trained 13 pediatric and 4 adult hematology/oncology physicians in the FTG-PRIDE Program. The significant number of clinicians trained in our program supports the career development of early stage hematologists conducting biomedical research.

To determine the success of didactic lectures and laboratory practicums, evaluation data were collected by the PCC. For the various parameters assessed (e.g., speaker effectiveness, interest of the topic, and achievement of course objectives), on a 7-point Likert scale the mean scores ranged from 5.34 ±0.43 to 6.6 ±0.22 (Supporting Information Figure S2). In addition, for continuous improvement of course content and topic focus, teaching faculty received individual evaluations. The mean scores for teaching faculty expertise and course ratings were 5.56 ±0.38 and 5.44 ±0.40, respectively.

The primary focus of all PRIDE Programs is mentorship, which is one of the most important supports linked to research funding, productivity, career advancement, and faculty satisfaction.[3] Therefore, extensive effort was made to establish successful mentor-mentee dyads based on mentor experience and common research interests. The mentors recruited to the FTG-PRIDE Program are established NIH-funded investigators from diverse disciplines, with expertise in grant writing and a willingness to establish long-term collaborations with their trainee. In partnership with mentees, PRIDE leadership identified research mentors prior to Summer Institute 1, and sponsored their travel to Augusta University to initiate the mentorship process; about 50% of mentors participated in this activity with the remaining unable to attend due to scheduling conflicts (Supporting Information Figure S3A). Within two months of Summer Institute 1, the remaining mentees traveled to the mentors' institutions to commence the mentoring process. In addition, mentees identify a home institution career development mentor to assist with professional growth and academic promotion, to establish the mentoring committee.

To promote mentoring success, we required formal monthly contacts between mentees and research mentors by phone or Skype, which complimented email communications; each month a brief report was submitted by mentees to the FTG-PRIDE office. Therefore, including the mid-year face-to-face meeting and participation in the National PRIDE meeting, each trainee completed on average 10 formal mentee-mentor contacts per year for 2 years (Supporting Information Figure S3A). To determine satisfaction with our mentoring process, mentees completed evaluation questionnaires. We observed mean scores ranging from 5.2 ±0.78 to 6.24 ±0.23 related to the effectiveness and satisfaction of mentees with their mentoring committee activities (Supporting Information Figure S3B). Our approach for assigning research mentors was highly successful, with only three mentees requiring reassignment due to a lack of mentor availability or a change in the mentees' research focus.

The primary metric of success for the PRIDE Program is the submission of at least one grant application for extramural funding within 2 years of training completion. However, two challenges must be addressed to increase NIH funding among URM groups, (1) the large difference in the number of NIH RPG applications submitted by URM investigators compared to Whites[1,2] and (2) the relative lack of competitiveness of grant applications from URM investigators based on scientific merit. In particular, 73% of applications from Blacks/African Americans were determined by review committees to not be of sufficient scientific

merit to be “fully discussed” during the initial stage of review, compared to 59% of applications from Whites.[1] Based on these observations, the PRIDE Program places special emphasis on developing the grant-writing skills of mentees through several approaches including dedicated NHLBI Program Officers providing annual grant writing workshops.

To collect data regarding the confidence of mentees in research-related skills, the CRAI-19 was administered annually for PRIDE 1 mentees. This abbreviated 19-item questionnaire developed in the PRIDE Program[6] evaluates 4 factors including study design/data analysis, writing skills, collaboration/grant preparation, and the consent process using an 11-point Likert confidence scale. We observed an increase in mentees’ confidence scores by 0.58 for writing skills and 2.2 points for study design/data analysis (Figure 1A); a significant overall increase in confidence scores over 5 years from 6.22 ±0.49 to 8.11 ±0.41 (P =.0393), supports enhanced research self-efficacy of FTG-PRIDE mentees.

To further assess the effectiveness of our training activities, the number of federal grants awarded to mentees was tracked by the PCC and confirmed using the NIH RePORTER database. Of the 34 mentees conducting hematology research, 25 (73.5%) achieved the primary metric of submitting at least one extramural grant within 2 years following training completion (Figure 1B). Of these 25 mentees, 16 (64.0%) obtained federal funding, mainly NIH Mentored Career Development Awards (K series) and RPG (Supporting Information Table S2); in fact, this group received 28 grants from 2006 to 2016, for an average of 1.75 grants per mentee. We observed an overall grant funding rate of 47.1% for the entire group of 34 PRIDE mentees evaluated in this report (Figure 1B). Our grant data can be compared to a funding rate of 27.3% for African Americans/Hispanics, and 35.2% for all racial and ethnic groups combined, for NIH mentored K awards from 2006 to 2012.[9] The 2014 Physician-Scientist Workforce Working Group Report[9] reported that RPG awards for first-time MD and PhD applicants with a prior mentored K award are much higher than those without prior K awards (55.2% vs 9.7%). Therefore, the large proportion of FTG-PRIDE mentees receiving K awards is expected to increase the success rates of RPG funding among our trainees. This prediction is particularly important, given the many challenges faced by ESI during the transition period to research independence.

Another important metric of success measured in the FTG-PRIDE Program which is required for ESI to achieve sustained grant funding and attain academic advancement, was the number of peer-reviewed publications. To evaluate success in this area, we tracked the number of papers published by mentees using Scopus and PubMed databases to verify self-reported data. Over 10-year and 5-year periods, SIPID mentees published 277 papers and PRIDE 1 mentees published 99 papers respectively (Supporting Information Table S2). These data further support the success of the FTG-PRIDE Program in enhancing the scholarly contributions of URM investigators to the field of hematology.

In conclusion, while the NIH has worked across institutes and centers to identify leverage points to overcome racial and ethnic disparities in the biomedical research workforce, individual institutes have devoted substantial resources to develop programs to increase diversity. One example of such commitment is the SIPID/PRIDE Program initiated by NHLBI in 2006. Here we described the outcomes of the FTG-PRIDE Program over a 10-

year period since its inception. The data presented herein demonstrated the success of mentees in competing for federal grant funding that surpasses the national average success rates.[9] Furthermore, using the CRAI-19 survey, we documented a significant improvement in the overall research self-efficacy of mentees. Our remarkable statistics regarding grant funding success rates, scholarly productivity, and academic promotions strongly suggest the investment of resources by NHLBI has been impactful.

While one of the desired outcomes of the FTG-PRIDE Program success is to increase the diversity of the biomedical research workforce, there are other benefits that will require more time to become apparent. For example, the issue of health disparities is closely related to aspects of workforce diversity, and both have been considered insurmountable problems.[3] Yet these complex interrelated issues may ultimately be favorably impacted by NHLBI's effort to support the FTG-PRIDE Program, since the overwhelming majority of mentees elected to conduct research related to improving treatments for sickle cell disease, a genetic disorder that disproportionately affects African Americans.

We note that many of the PRIDE program directors are from URM backgrounds, and as such, know firsthand the challenges faced in establishing an independent research career in academic medicine. The data presented here demonstrate the short-term impact that mentored-training programs can make on diversifying the biomedical research workforce and long-term positive outcomes for society. Continued federal support for this program is clearly justified, and future studies will allow us to further refine the objectives and design of mentored training programs to optimize their overall effectiveness. Studies evaluating the success of the PRIDE Program compared to training supported by professional societies such as the American Society of Hematology, Clinical Research Training Institute[10] will be of interest with regards to their impact and the approaches used, to achieve shared training objectives.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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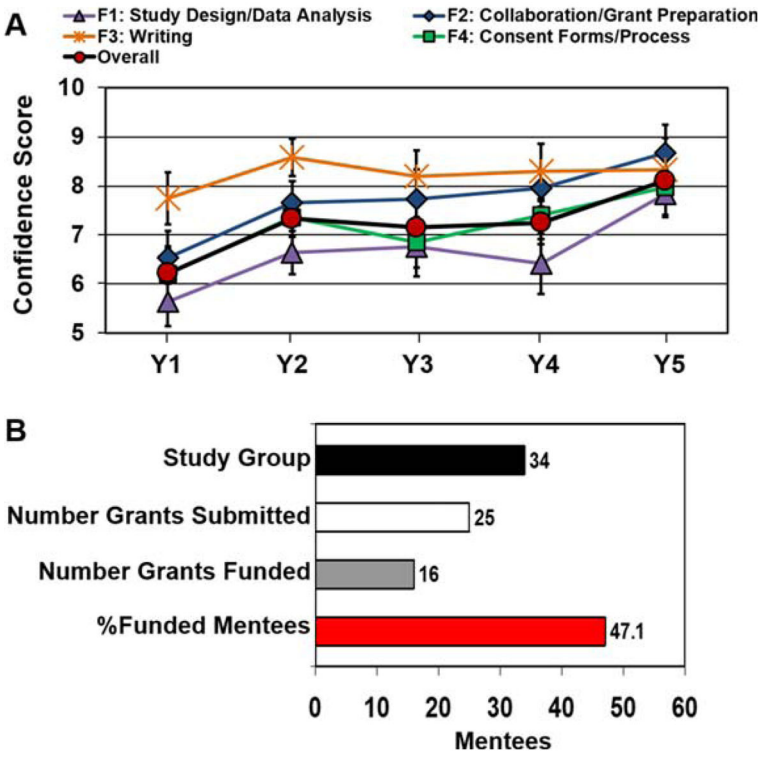

FIGURE 1.

PRIDE mentees report improved self-efficacy in conducting research and were awarded substantial federal grant funding. (A) The abbreviated Clinical Research Appraisal Inventory (CRAI) was used to evaluate the confidence of mentees to conduct research on an 11-point Likert scale between 0 (no confidence) and 11 (total confidence). CRAI data are shown only for PRIDE 1 mentees since this tool was not established during the SIPID Program. The change in overall confidence score was evaluated with SAS software (Version 9.4 of the SAS System for Unix using the mixed procedure; SAS Institute Inc. 2002–2012, Cary, NC) for repeated measures and unequal N values. The change in overall self-efficacy score from Year 1 to Year 5 (Y1-Y5) was significant (P =.0393), and this effect was dominated by the change from year 1 to year 5. Data are shown as the mean ±standard error mean; P values <. 05 are considered statistically significant. (B) Shown is the number of grants submitted by the 34 mentees trained in SIPID and PRIDE 1 conducting hematology research. The overall grant funding rate for the group is shown in the red graph.

TABLE 1

Demographics of the FTG-PRIDE mentees conducting hematology research

	SIPID (18)	PRIDE 1 (16)	Total (34)	Percent
Gender				
Male	6	2	8	23.5
Female	12	14	26	76.5
Race/ethnicity				
African American	14	13	27	79.4
Hispanic	3	0	3	8.8
Other[a]	1	3	4	11.8
Faculty rank				
Assistant Professor	14	15	29	85.3
Other[b]	4	1	5	14.7
Degree				
MD	8	11	19	55.9
PhD	8	3	11	32.4
Other[c]	2	2	4	11.7
Type of research				
Clinical/translational	12	9	21	61.8
Basic Science	4	3	7	20.6
Public Health	0	3	3	8.8
Psychology	2	1	3	8.8

[a]Other—2 Asian, 2 mixed races.

[b]Other—2 Instructors, 1 Research Associate, 1 Research Scientist, and 1 Postdoctoral Fellow.

[c]Other—1 MD, PhD, 1 DVM, 1 DrPH, 1 EdD.