Original Report:
Increasing Diversity in the
Biomedical Workforce

The Association Between NRMN STAR Grantsmanship Self-Efficacy and Grant Submission

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Background: Eliminating the NIH funding gap among underrepresented minorities (URMs) remains a high priority for the National Institutes of Health. In 2014, the National Research Mentoring Network[1] Steps Toward Academic Research (NRMN STAR) program recruited postdoctoral, early-stage and junior faculty to participate in a 12-month grant writing and professional development program. The expectation of the program was to increase the number of grant submissions and awards to URM researchers. Although receiving a grant award is the gold standard of NRMN STAR, instilling confidence for postdocs and early-stage faculty to submit an application is a critical first step. Based on our previous study, a sustained increase in trainee self-efficacy score over a 24-month period was observed after completing NRMN STAR.

Methods: The current study sought to determine the association between self-efficacy score and grant submissions among two cohorts of trainees. Grantsmanship Self-Efficacy was measured using a 19-item questionnaire previously described by and used in our own work, which was originally adapted from an 88-item Clinical Research Appraisal Inventory.[2] A binary variable was created to identify trainees who submitted an initial or revised proposal vs those who abandoned their proposal or were still writing. Trainees were assessed prior to and following program completion with subsequent assessments at 6 and 12 months beyond participation.

Results: As of June 20, 2019, 12 of the 21 (57%) trainees had submitted a grant proposal (eg, NIH, other federal or non-federal grant). For every point increase in 12-month post assessments, Grantsmanship Self-Efficacy scores across all domains had a 44% higher prevalence of submitting a grant after controlling for race, sex, education level, academic rank, research experience, duration of postdoctoral training, institution type, and NRMN STAR cohort.

Conclusions: Our findings demonstrate that NRMN STAR had a positive impact on trainees' confidence in grant writing and professional development activities, which resulted in higher grant submission rates. *Ethn Dis*. 2021;31(4):559-566; doi:10.18865/ed.31.4.559

Keywords: Early Career Faculty; Grant Writing; Self-Efficacy; Underrepresented Minority; Coaching; Professional Development

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Introduction

The participation of individuals from diverse racial/ethnic backgrounds (eg, African Americans, Hispanics, Native Indian and Alaskan Pacific Islanders and persons with disabilities) in the research workforce is of high importance to the National Institutes of Health (NIH),[3] arguing that new medical discovery emerges from different perspectives in solving complex and nuanced biological problems. In addition, as the United States demographic becomes increasingly diverse, NIH's expectation is that groups underrepresented in health sciences will be valuable contributors to its research mission of improving health of its citizenry. Therefore, it is imperative that early-stage investigators, particularly those from

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racial/ethnic backgrounds, are prepared with career development and grantsmanship training skill sets to enter and succeed in research careers.

A career in biomedical research, particularly in academic settings, requires investigators to garner extramurally sponsored research awards to maintain standing at their college, university, or health research center/institute. For many, receipt of a major NIH-supported grant award (eg, R01, R21), is the barometer for promotion and tenure. Unfortunately, the number of underrepresented minorities (URMs) submitting and receiving NIH awards remains disproportionately lower than their non-URM counterparts (eg, non-Hispanic White, Asian). In a recent report from the Office of Workforce Diversity, Chief Operating Officer, Dr. Hannah Valantine reaffirmed the persistent disparity between first-time NIH R01 applications from African American and White faculty researchers as previously documented in the sentinel study by Ginther and colleagues.[4] Valantine documented that the lower percentage of African Americans with R01-type grants compared with Whites was 11% vs 17%, respectively, between FY2011 and FY2015, noting that these percentages were trending lower than between FY2000 and FY2006, when the percentage of African American with R01-type grants was 17% compared with 29% of Whites.[5] In addition, relative to their White peers, African American investigators: submitted fewer initial R01 grant applications; received poorer overall priority scores; and resubmitted unfunded proposals less frequently.[5] Based on these findings, the goal of diversifying the academic research workforce is in serious jeopardy and may negatively impact NIH's ability to create solutions to health problems of the future.

The objective of this study was to determine the association between grant proposal writing self-efficacy and submission of a grant proposal.

NIH addressed these challenges by initiating training opportunities for early-stage investigators focused on increasing grant writing proficiency and professional development by assembling a collaboration of investigators having a successful track record in grantsmanship programming. In 2014, the National Research Mentoring Network[1] was established to implement best practices in grant writing, considering a researcher's skill level and career.[1,6] Among the five programs offered, the NRMN STAR program created a 12-month grant writing coaching and professional development curriculum[1,6,7] for post-doctoral and junior investigators with no previous record of NIH grant funding and minimal grant development experience. Over the course of the 12-month program, experienced grant writers were invited from across the United States to serve as coaches to deliver face-to-face trainings on the fundamentals of grant writing and the preparation of NIH-style grants. Trainees also received supplemented skill and professional development resources that were often absent at their home institution.[7]

The skills needed to develop a fundable grant proposal requires training and experience including formulating a fundable research question, communicating in a well-organized and logical fashion, understanding of the grant submission support mechanism at their home institution, and how to interact with NIH program officers. In a report by the Governmental Accountability Office[8] on funding, most awards were made to investigators with a previous funding history.[9] This is testimony to the persistence required of investigators for establishing a sustainable research program.[10] To this end, self-efficacy, particularly among URMs pursuing biomedical careers paths is emerging as an important predictor of persistence.[7,11] In our most recent studies, we assessed the perceived self-efficacy of two cohorts of NRMN STAR using an abbreviated, 19-item grant writing self-efficacy assessment[12] drawn from the Clinical Research Appraisal Inventory (CRAI)[13] to confirm the reliability of three factors (conceptualizing, designing and funding a study) to predict the likelihood that self-efficacy influences biomedical and behavioral science researchers submitting grant proposals across NRMN professional development coaching groups.[7] Findings from the assessment demonstrated improvements in grant writing self-efficacy from program inception to 12-months post-completion of the program. NRMN STAR train-

ees were expected to submit their NIH grant proposal within one year of completing their program.

The objective of this study was to determine the association between grant proposal writing self-efficacy and submission of a grant proposal. We hypothesized that individuals with higher Grantsmanship Self-Efficacy scores would have higher likelihood of submitting grant proposals.

Methods

NRMN STAR

Trainees of NRMN STAR were recruited from a national pool of post-doctoral fellows, early-stage and junior faculty. Candidates selected were those individuals having limited grant writing experience and needing more than six months to develop a grant proposal based an assessment of their application. Trainees participated in face-to-face and virtual meetings over a 12-month period focused on improving grant writing skills, navigating the application process, and professional and career advancement. Trainees were expected to submit a grant application within the grant cycle following completion of the program. The NRMN STAR curriculum is described in detail by Jones and colleagues.[6]

Trainee Data Collection

Data from trainees were collected over a 30-month period. Trainees were given a pre-assessment prior to starting the program, a post-assessment at the completion of the 12-month program, and post-assessment surveys every six months for up to 18 months.[7] Trainees were asked to complete a 19-item Grantsmanship Self-Efficacy assessment[12] that was adapted from the 88-item CRAI.[13] In addition, data were collected to gather self-reported information on the status and dates of grant submissions and awards. All data including race/ethnicity, sex, educational level, academic rank, institution type, postdoctoral research training and research experience were collected by administering the questionnaires in REDCap.[14] All trainees were strongly encouraged to complete each assessment survey. To date, two cohorts (total of 21 individuals) have participated in NRMN STAR. This report is based on data from the first two cohorts (11 and 10 trainees, respectively), who participated in the initial two years of NRMN STAR.[7] Appropriate institutional review board entities originally from the University of Minnesota and transferred to the University of Utah and partnering institutions deemed the status of this work to be exempt.

Trainee Characteristics

Demographic characteristics of NRMN STAR trainees were collected by self-report. Trainees reported their race/ethnicity as Asian, Black, Hispanic/Latino, Native Indian and Alaskan Pacific Islanders, or more than one race. Trainee sex was reported as being male or female. Educational attainment of trainees was collected based on report of advanced degrees each participant had obtained. The responses included: none, Bachelor, Masters, PhD, postdoctoral training, MD, MD/PhD, DDS, DVM, PharmD, and other. NRMN STAR cohort (1 or 2) was based on the year in which the trainee participated. In addition, trainees were asked to report on their academic characteristics after completing their terminal degree. These characteristics included academic rank, postdoctoral research training, research experiences, and institution type. Trainees reported their current employment level: postdoctoral associate/fellow, instructor, assistant professor, or other (eg, scientist in non-academic setting). Trainees were also asked about their duration of postdoctoral training, ranging from none to >3 years, and any subsequent research experience, ranging from none to >5 years. Response options for both items included: none for training and none/<1 year for experience); 1 year and 1-2 years, 2-3 years, 3-5 years; and >3 years and >5 years. Institutional type was defined as either Minority-Serving Institution (MSI) or Non-Minority Institution (Non-MSI). MSI is defined as either a Historical Black College or University (HBCU), Hispanic Serving Institution (HSI), Tribal Colleges and Universities (TCUs), or Asian American and Pacific Islander Serving Institutions (AAPISIs). All other institutions were defined as Non-MSIs.

Measures

The outcome variable used in this study was submission of one or more grant proposals. Trainees reported their stage in the writing process for the grant proposal that they initiated in NRMN STAR. Responses included the following: still writing (no submissions); submitted initial proposal; submitted revised proposal; abandoned proposal; and other. A binary variable was created to identify trainees who submitted an initial proposal,

submitted revised proposal vs those who abandoned proposal or were still writing. Trainees who reported "other" were excluded from data analysis.

Grantsmanship Self-Efficacy

Originally adapted from the 88-item CRAI,[2] Grantsmanship Self-efficacy was measured using a 19-item questionnaire described by[12] and used in our previous work.[7] Three domains of grantsmanship were captured in the 19-item instrument. These included: conceptualizing a study (8 items); designing and analyzing a study (7 items); and securing funding of a study (4 items). Trainees rated their level of confidence in performing grantsmanship tasks using a 0- to 10-point scale where 0 represented no confidence and 10 indicated complete confidence in one's ability to successfully perform the task. The scores from each domain were summed, averaged, and recorded for each trainee.

Analyses

Frequency distributions, means, and standard deviations were used to summarize the total sample. Significant differences in the proportion of demographic and academic characteristics were determined using Chi-square test. Student's t test was used to examine mean differences in the 12-month post-assessment of Grantsmanship Self-Efficacy scores. Instead of logistic regression models, Modified Poisson regression models were conducted to determine the association between grant writing self-efficacy and grant proposal submissions. Modified Poisson regression models are deemed appropriate because the prevalence of the outcome variable grant submission is greater than 10%.[15] Four models were specified for this study. Each of these models were controlled for by demographic and academic-related characteristics across all domains and each confidence domain. All statistical tests were two-sided; P<.05 were considered statistically significant. Analyses were conducted using STATA version 14.

Table 1. Distribution of demographic characteristics of the first two cohorts of NRMN STAR, total sample and by grant submission status

		Grant submitted		
Characteristic	**Total, N =21**	**No, n=9**	**Yes, n=12**	**P**
Demographic				
Race/ethnicity, %				.501
Asian	4.7	0.0	8.3	
Black	61.9	66.6	58.3	
More than one race	4.7	11.1	0.0	
Hispanic/Latino	28.5	22.2	33.3	
Sex, %				.604
Male	38.1	44.4	33.3	
Female	61.9	55.5	66.6	
Education level, %				.352
MD	4.7	0.0	8.3	
PhD	90.4	88.8	91.6	
MD PhD	4.7	11.1	0.0	
NRMN STAR0, %				.004
Cohort 1	52.3	88.8	25.0	
Cohort 2	47.6	11.1	75.0	

NRMN STAR, National Research Mentoring Network Steps Toward Academic Research

Results

Characteristics of Trainees

Most trainees reported their race/ethnicity as Black (61.9%), their sex as female (61.9%), or having obtained only their PhDs (90.4%). There were no observed differences in the demographic characteristics by grant submission status (Table 1).

Most trainees were assistant professors, reported none or <1 year of research experience, had at least one year of postdoctoral training, or were from non-MSIs. No differences were observed between the academic characteristics and grant submission status (Table 2).

The mean 12-month post-assessment Grantsmanship Self-Efficacy score across all three domains was 8.2±1.3. Similarly, when examining the mean 12-month post-assessment Grantsmanship Self-Efficacy for each domain, the means for were as follows: conceptualize a study, 8.4±1.3; design a study, 8.0±1.5; and fund a study, 8.1±1.5. There were no observed mean differences between those who submitted a grant and those who did not as it relates to the 12-month post-assessment of Grantsmanship Self-Efficacy scores across all the domains or any specific domain (Table 3).

After controlling for race, sex, education level, academic rank, research experience, duration of postdoctoral training, institution type,

and NRMN STAR cohort, we found that a 44% higher prevalence of submitting a grant proposal directly correlated with every point increase in 12-month post-assessment Grantsmanship Self-Efficacy score for each domain and all the domains combined. When examining the 12-month post-assessment Grantsmanship Self-Efficacy Score for the Conceptualize a Study Domain, there was a 47% higher prevalence of submitting a grant proposal. Similarly, for the 12-month post-assessment Grantsmanship Self-Efficacy score for the Design a Study Domain, there was a 57% higher prevalence of submitting a proposal. There was no significant relationship between the Fund a Study 12-month post-assessment Grantsmanship Self-Efficacy Score and submitting a grant (Table 4).

Table 2. Distribution of academic characteristics of the first two cohorts of NRMN STAR, total sample and by grant submission status

		Grant submitted		
Characteristic[a]	**Total, N =21**	**No, n=9**	**Yes, n=12**	**P**
Academic rank, %				.465
Postdoctoral trainee	42.8	44.4	41.6	
Assistant professor	52.3	44.4	58.3	
Other	4.7	11.1	0.0	
Postdoctoral research training, %				
None	23.8	33.3	16.6	.387
1 year	38.1	44.4	33.3	
2-3 years	23.8	22.2	25.0	
>3 years	14.2	0.0	25.0	
Research experience, %,				.171
None or <1 year	57.1	77.7	41.6	
1-2 years	19.0	22.2	16.6	
3-5 years	19.0	0.0	33.3	
>5 years	4.7	0.0	8.3	
Institution type, %				.676
Non-minority serving institution	71.4	66.6	75.0	
Minority serving institution	28.5	33.3	25.0	
Grant submission, %	57.1			

NRMN STAR, National Research Mentoring Network Steps Toward Academic Research
a. Research experience is defined as the amount of experience beyond (not including) any postdoctoral research training

Discussion

Diversifying the biomedical research workforce remains a significant priority of the NIH and other health research enterprises. While academia remains a mainstay to pursue a biomedical research career, few would argue that success and career trajectory cannot be achieved without obtaining major extramural funding. This reality places significant pressure on early-stage investigators to acquire the skills needed to prepare a competitive grant application. For many years, training of early-career scientists on how to craft grant proposals has been an important priority of NIH's diversity initiatives.[6,16,17] However, as noted in various NIH reports and publications on URM award success, gains from grant writing training programs have only modestly increased over the past 10 years.[3,18] Our findings demonstrate that NRMN STAR program had a positive impact on trainees' confidence in grant development and professional development activities resulting in higher grant submission rates.

In our recently published study,[7] we demonstrated that the comprehensive 12-month curriculum of NRMN STAR increased and sustained trainee self-efficacy for up to 24 months since the start of the trainee's participation, the time in which trainees were

Table 3. Mean comparison of the 12-month post-assessment grantsmanship self-efficacy scores for total sample and by grant submission status for the first two cohorts of the NRMN STAR, N=18[a]

		Grant submitted		
Domain Type	**Total[b], N=18**	**No[b], n=9**	**Yes[b], n=9**	**P**
All domains (19 items)	8.2±1.3	8.0±1.1	8.3±1.5	.633
Conceptualize a study (8 items)	8.4±1.3	8.3±1.2	8.5±1.4	.714
Design a study (4 items)	8.0±1.5	7.8±1.5	8.1±1.7	.713
Fund a study (7 items)	8.1±1.5	7.8±1.4	8.3±1.6	.464

NRMN STAR, National Research Mentoring Network Steps Toward Academic Research
a. 18 of 21 trainees were included as 3 trainees did not complete the self-efficacy assessments over the course of the assessment period.
b. Confidence self-efficacy in ability to perform associated tasks; item scale = 0 to 10, 'no confidence' to 'complete confidence'.

Table 4. Association between grant submission and 12-month post-assessment grantsmanship self-efficacy scores across all domains and by domain for the first two cohorts of NRMN STAR cohorts, N=18[a]

	Models			
	All domains	**Conceptualize a study**	**Design a study**	**Fund a study**
	(19 items)	**(8 items)**	**(4 items)**	**(7 items)**
PR (95% CI)	1.44(1.02,2.04)	1.47(1.03,2.08)	1.57(1.06,2.33)	1.13(0.82,1.53)

NRMN STAR, National Research Mentoring Network Steps Toward Academic Research; PR, prevalence ratio; CI, confidence interval
a. 18 of 21 trainees were included in these models as 3 trainees did not complete the self-efficacy assessments over the course of the assessment period. Each of the models controlled for race, sex, education level, academic rank, research experience, duration of postdoctoral training, institution type, and NRMN STAR cohort.

expected to submit their grant proposal. Appropriately, when the two cohorts of NRMN STAR completed their 24-month assessment (June 20, 2019), the Advisory Committee to the NIH director (ACD) met in June 2019 to discuss progress toward closing the gap between URM and non-URM investigator grant award success rates. At the forefront of actionable strategies was to increase submission rates among African American/Black (AA/B) trainees. In the ACD report, AA/B showed a 28.9% increase in grant submissions between FY2013 and FY2108 (outcomes included R01 and non R01-type awards).[19] Thus, trainee grant submission became one of the primary metrics of success for NRMN STAR.

Our findings demonstrate that NRMN STAR program had a positive impact on trainees' confidence in grant development and professional development activities resulting in higher grant submission rates.

Overall, more than half (57%) of trainees of the combined cohorts submitted a proposal (NIH, other federal and non-federal proposal) within 24 months following their participation. Whereas only 2 out of 10 trainees of cohort 1 submitted their grant proposal, nine of 11 trainees of cohort 2 met the submission metric. Although there were no observed differences by demographic or academic characteristics of trainees (Tables 1 and 2), other variables may have been associated with this difference between cohort outcomes. For example, group dynamics including similarity among trainees related to research area, composition of the faculty coaching group (eg, sex, race/ethnicity, discipline, grant writing experience), could be one of several individual and group characteristics. We expect that the inclusion of future cohorts currently being surveyed will provide additional insight of cohort characteristics beyond those reported in this study.

Identifying factors that predict successful grant submission outcomes could benefit from the development of appropriate strategies or interventions for early-stage investigators, particularly among URMs. Emerging research indicates that multiple variables serve as predictors of success for early career investigators; these variables include writing skill development, institutional support, mentoring, coaching and individual development planning.[6,20-23] Some studies have found that implementing a comprehensive approach to grant writing training can lead to an increase in trainee self-efficacy.[7,12] In support, previous work in other disciplines and within academia point to self-efficacy as a critical determinant in advancing through career transition points.[24,25] Grantsmanship Self-Efficacy scores across all domains (Conceptualize a Study, Design a Study and Fund a Study) had a 44% higher prevalence of submitting a grant controlling for all demographic and academic characteristics of participants in NRMN STAR. Interestingly, in contrast to the domains, Conceptualize a Study and Design a Study, trainee self-efficacy for the Fund a Study domain was not associated with grant submissions.

Most trainees had little-to-no

prior grant writing experience and had never navigated a grant submission; this lack of experience may have contributed to lower Grantsmanship Self-Efficacy scores in the Fund a Study domain. In addition, it should be noted that a majority of trainees entered NRMN STAR with little-to-no history of publishing and/or evidence of prior funding; therefore, they would be less likely to generate a competitive grant application, particularly a major NIH grant award (eg, R01, SC1). These points were emphasized during the training, which may have influenced confidence associated with trainee's ability to acquire grant funding. Future assessments that determine grant awards received by trainees will likely be a better measure of self-efficacy related to confidence in receiving funding. Nevertheless, trainees' self-efficacy scores for the Conceptualizing Study domain and Design a Study domain were in agreement with the NRMN STAR's curriculum focus and attention to the cohort's appropriate stage of grant writing readiness.

Limitations of the Study

Several limitations should be acknowledged with respect to our current findings. We recognize that the total number of trainees across both cohorts is small. Due to a small sample size, we were unable to examine the association between grant proposal submission and Grantsmanship Self-Efficacy by individual characteristics (eg, sex, race/ethnicity, education). However, the size of our cohort is typical of other NRMN programs.[6,12] Secondly, it is worth noting that the majority of participants were from Black/African American (62%) and non-White Hispanic (26%) racial/ethnic backgrounds. Despite these limitations, our outcomes and interpretations are based on a validated Grantsmanship Self-Efficacy scale on this population.[7,12] Future research is needed with a sufficient number of participants for comparison with non-URM early-stage investigators. In addition, trainees of NRMN STAR were recruited from a national pool representative of research-intensive and minority-serving institutions. We expect that as future NRMN STAR trainee assessments are completed; additional outcome data will allow for detailed stratification across individual characteristics as a determinant of grant submission outcomes.

Conclusions

Efforts are ongoing to understand the factors that determine grant writing success for early-stage investigators, particularly among underrepresented minorities.[26] For example, recent studies have documented the relevance of prior publication record, level of institutional support, and the type of research area to be influential predictors of grant success.[4,27] In addition to these and other objective measures, researchers are acknowledging the importance of qualitative attributes (eg, belief systems) that create a comprehensive view of what practices and interventions may improve grant outcomes.[1,6,7,28]

The findings presented here are an extension of our previously published work which highlighted the positive impact of NRMN STAR on a trainee's self-efficacy.[7,12] Consistent with our prior outcomes, our findings here support that NRMN STAR, which includes professional and grant development, along with confidence-building activities, resulted in the majority of participants submitting a grant application. As we collect additional outcome results from current and future NRMN STAR trainees, we will determine associations of grant self-efficacy with proposal submission and grant awards. Our long-term expectation is that trainees of NRMN STAR will have a positive impact on increasing the number of Black and other racial/ethnic researchers submitting and receiving NIH awards and thus, support NIH's commitment to diversifying the research workforce.

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Availability of Data Materials

The manuscript's supporting data can be accessed upon reader's request to the corresponding author.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Jones, Vishwanatha, Krug, Boman, Unold, Thorpe; Acquisition of data: Jones, Krug, Boman, Unold, Thorpe; Data analysis and interpretation: Jones, Thorpe; Manuscript draft: Jones,

Vishwanatha, Krug, Harwood, Boman, Unold, Thorpe; Statistical expertise: Jones, Harwood, Thorpe; Acquisition of funding: Jones, Vishwanatha; Administrative: Jones, Krug, Thorpe; Supervision: Jones, Thorpe

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