Assessing the value of a Small Grants Program for behavioral research in cancer control

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Cite this as: *TBM* 2014;4:79–85
doi: 10.1007/s13142-013-0236-x

ABSTRACT

In 1999, the National Cancer Institute (NCI) issued the first Small Grants Program (SGP) for Behavioral Research in Cancer Control (R03) funding opportunity announcement for investigators new to behavioral cancer prevention and control research. We explored whether the SGP was successful in its goals to encourage new investigators from a variety of disciplines to apply their skills to and promote career development in behavioral cancer prevention and control research. A quasi-experimental design examined applicant characteristics and outcome data by award status. Propensity score matching was used to compare awardees and non-awardees with similar impact scores as a control for application quality. Awardees were more likely than non-awardees to pursue and receive subsequent funding from the NCI and publish their research. Tailored small grant programs create benefit for both promoting and retaining new investigators.

KEYWORDS

Small grants, Behavioral research, Program evaluation

INTRODUCTION

In 1999, the Division of Cancer Control and Population Sciences (DCCPS) of the National Cancer Institute (NCI) released the first investigator-initiated “Small Grants Program (SGP) for Behavioral Research in Cancer Control” (R03) funding opportunity announcement (FOA). The R03 funding mechanism is utilized by the National Institutes of Health (NIH) to support research projects that can be carried out in a short period of time (maximum of 2 years) with limited resources (maximum allowable direct costs of US\$100,000). Following an environmental scan, the DCCPS’s newly developed Behavioral Research Program (BRP) identified the R03 mechanism as an opportunity to stimulate the field by encouraging new investigators and established investigators interested in refocusing their expertise to apply their skills to behavioral cancer prevention and control research.

The BRP–SGP was novel in its approach. In addition to providing modest funds to support a growing area of research, the FOA was tailored to

Implications

Practice: NIH small grant mechanisms in behavioral research are viable funding opportunities for practitioners in at least 66 diverse fields of expertise.

Research: New investigators applying for small grants should communicate with scientific staff both prior to submission and post-review as well as work with experienced mentors to develop and implement studies.

Policy: Resources should be directed towards the further development of methods, measures, and data sources that best evaluate the scientific and career outcomes of funding opportunities.

address four specific processes identified as critical to the goal of attracting and nurturing a cohort of scientists: eligibility, review, mentoring, and post-award follow-up. First, only investigators new to the field of behavioral cancer prevention and control research were invited to apply (i.e., applicants who had not been principal investigators on a prior NCI-funded research program grant focused on cancer prevention and control science). Second, the FOA was designated a program announcement with special review considerations (PAR) based on the rationale that applications would be assigned to a NCI-designated special emphasis panel (SEP) comprised of reviewers with behavioral cancer control expertise. Third, because the FOA required investigators to be new to the field of behavioral cancer prevention and control research, applicants were required to submit a mentoring plan that identified a senior investigator with both cancer control and NIH funding experience to provide guidance and support for study development, execution, and advancement. Lastly, upon completion of year 1 funding, principal investigators (PIs) were required to budget for and attend a 2-day meeting sponsored by the NCI. The intent of the meeting was to provide networking opportunities for PIs with other behavioral scientists and NIH scientific staff and to help PIs identify opportunities to advance their program of research.

The program has been well received by the research community with 542 unique applicants, 46 % ($n=247$) of which successfully competed for and were awarded a small grant. From 1999 to 2011, awardees received more than US\$39 million in funding through this program. Applications represented a broad scope of behavioral science focused across multiple continuums including age and development (childhood to older adults), cancer control (primary prevention through survivorship), and research (basic to applied).

The decade-long program was a significant investment by the NIH to encourage investigators to apply their multi-faceted skill sets and expertise to stimulate promising areas of behavioral cancer control research. Historically, NIH small grant programs have not been utilized as a mechanism to cultivate a cohort of new investigators in a given field. This study was initiated to better understand the extent to which the BRP-SGP met its primary goals: (1) to encourage new investigators from a variety of disciplines, and those refocusing their research interests to apply their skills to behavioral cancer control research, and (2) to promote career development of investigators new to the field of behavioral cancer control. Our evaluation of the program includes a matched comparison group of non-awardees to help establish program impact. In an attempt to mimic randomization, propensity score matching methodology was used to make the awardee and non-awardee groups more comparable for the primary indicators of subsequent NCI grant funding and publications. Using a similar approach to that employed in evaluations of educational interventions in which test score cutoffs are used, we likened review-generated priority scores to a test score and the NIH payline to the test score cutoff. Person-matching techniques were also employed and applied to multiple databases in an effort to supplement our primary NIH-generated database. The merging of data from multiple sources allowed for a more comprehensive analysis focused on matching characteristic and outcome data to program goals.

An earlier evaluation of the small grant program in 2005 with the original 64 BRP-SGP awardees revealed several relevant conclusions [1]. The study examined awardees' post-award research, publications, presentations, and professional interactions within the field of behavioral research in cancer control. Based on the information from grantee surveys and curricula vitae as well as mentor interviews, the evaluation concluded that the BRP-SGP facilitated independent research opportunities for early career investigators and had a positive effect on career development. Participating grantees viewed the program as having an important career impact, especially because the BRP-SGP provided funding opportunities at an early career stage and allowed researchers to become familiar with the NIH grant application process. They described this grant mechanism as an ideal "bridge" for junior investigators to perform well-defined, short-term projects that had the

potential to develop into R01 research programs. The most identified impact of the BRP-SGP was determined to be the opportunity to collect pilot data, which has become increasingly important for writing a strong R01 proposal. These early evaluation findings were limited by a small sample size, the dependence on self-report, and the lack of non-awardee data for a comparison cohort. In addition, the authors noted significant challenges in identifying appropriate metrics of success and matching them to specific programmatic goals. These limitations were addressed in the current study.

METHODS

This study employed a quasi-experimental design and examined all of the applicants who responded to the BRP-SGP program announcements from 1999 to 2009. The study included individuals who applied to the first SGP program announcement (PAR 99-006) and the three subsequent reissued funding opportunity announcements (PAR 02-037, PAR 04-020, PAR 06-73 and PAR 06-458) because these individuals had a minimum of 2 years post-grant award time in the field. The sample included 247 awarded applicants, and a comparison group comprised of the 295 unfunded applicants. Descriptive characteristic and outcome data were collected on the full cohort of awardees and non-awardees. Doctoral-level field of study data were collected as an indicator of the BRP-SGP's success in attracting applicants from a wide range of disciplines. Career development measures included assessment of subsequent cancer control-related grant activity and bibliometric indicators such as number of publications and impact factors.

To better examine subsequent NCI grant activity and publication as indicators of program impact, propensity score matching was employed in which a subset of the cohort, both awarded and non-awarded candidates—with similar priority scores for each BRP-SGP PAR—was the unit of analysis. The priority score range in which there is an equal number of awarded and not awarded applications is referred to as the "funding bubble" as illustrated in Fig. 1. The bubble cohort was constructed to include applicants who have applications of similar quality, as determined by priority score and an equal likelihood of being funded or not funded. This priority score range can change from year to year, and thus for each BRP-SGP PAR evaluated, funding bubbles were determined for each fiscal year and combined into a single pool that was used to evaluate subsequent grant outcomes. The final BRP-SGP bubble cohort contained 184 total applications (92 awardees and 92 non-awardees) and represented 34 % of the total study population. The demographic characteristics of the bubble cohort reflected the study population as a whole. A more detailed description of this method is available in the final evaluation report (available online at http://cancercontrol.cancer.gov/brp/smallgrants/docs/2012_Evaluation-acc.pdf).

Fig 1 | Bubble cohort methodology illustrates how the funding bubble is derived from the priority score and number of applicants for both funded and not funded applicants

Data sources

Applicants were identified through the NIH's Information for Management, Planning, Analysis, and Coordination (IMPAC II) grant database. The IMPAC II database was the primary data source used to obtain information on individual characteristics and outcomes. Data were supplemented with information from the National Science Foundation's Doctoral Record File (DRF) and the Association of American Medical Colleges' Faculty Roster. Subsequent funding from non-NIH funding sources by BRP-SGP applicants was assessed using name-matching algorithms across the databases of member organizations within the International Cancer Research Portfolio (ICRP) (full list of US partners available online at <https://www.icrpartnership.org/partners.cfm>), the Livestrong Foundation, the Department of Defense Congressionally Directed Medical Research Program (DOD CDMRP), and the National Science Foundation (NSF). Publication and associated bibliometric data were assessed using name-matching algorithms across the National Library of Medicine's MEDLINE database and Thomson Reuters' Web of Science. Publications that directly cited the BRP R03 grant number determined the number of publications specifically resulting from BRP-SGP funding.

RESULTS

Table 1 provides descriptive characteristics of the full cohort of awarded and not awarded BRP-SGP applicants. The majority of BRP-SGP R03 applicants and awardees were white females who hold a Ph.D. degree. The average age of awardees was 40 years, and the median was 38 years with age data available for 94 % of the sample ($n=232$). Age data

for awardees showed two distinct peaks—one in the mid 30s and the second at age 42. The majority of awardees applied to the program 3 to 8 years after receiving their highest degree ($M=7.3$ years; $med = 5$ years) and had no prior NIH research project grants (RPG) or career development award support. Of those who had prior NIH funding, the most common was T32- National Research Service Award Institutional Training grants (20 % awardees and 14 % non-awardees).

Goal 1: attracting a wide array of disciplines to the field of behavioral cancer prevention and control research

Applicant's field of study (FOS) was examined to determine whether the BRP-SGP encouraged investigators from a variety of disciplines to apply their skills to behavioral research investigations in cancer prevention and control. For applicants with a Ph.D., the NSF's DRF was used to obtain information about the Ph.D. field of study. Of the 542 applicants, 418 hold either a Ph.D. or M.D./Ph.D. degree, and of those, FOS data were available for 324 (76 %). Three levels of Ph.D. field of study were explored for this study based on the aggregated categories identified in the Survey of Earned Doctorates conducted annually for the NSF [2]. For tier 1, which includes the broadest categorizations, BRP applicants were matched to 10 of the 12 total identified categories. Tier 2 categorized field of study even further; for example, clinical psychology and social psychology fall under the tier 1 classification of psychology, and agricultural sciences and natural resources, biological sciences/biomedical sciences, and health sciences were categorized under the tier 1 classification life sciences. Tier 3 was also divided further; for example, epidemiology and public health were classified under the tier 2 category health sciences.

Table 1 | Descriptive characteristics in both samples

Parameter	Category	Awardees (<i>n</i> =247)	Non- awardees (<i>n</i> =295)	Success rate by category
Degree type	Ph.D.	194 (79 %)	202 (68 %)	49 %
	M.D.	22 (9 %)	49 (17 %)	31 %
	M.D./Ph.D.	7 (3 %)	15 (5 %)	32 %
	Dual ^a	4 (2 %)	2 (1 %)	67 %
	Master's degree, professional certification (e.g., FAAN, RN, OTH), or other	17 (7 %)	24 (8 %)	41 %
	Unknown	3 (1 %)	3 (1 %)	–
Gender	Male	89 (36 %)	108 (36 %)	45 %
	Female	154 (62 %)	170 (58 %)	48 %
	Unknown	4 (2 %)	17 (6 %)	–
Race/ethnicity	White	156 (63 %)	150 (51 %)	51 %
	Asian	20 (8 %)	25 (8 %)	44 %
	Black	5 (2 %)	15 (5 %)	25 %
	Hispanic	10 (4 %)	13 (4 %)	38 %
	Native American	*	*	–
	Others	1 (0.4 %)	5 (2 %)	20 %
	Unknown	54 (22 %)	86 (29 %)	–
Prior support	Prior NIH support (training, RPG, others)	110 (45 %)	118 (40 %)	48 %
	No prior NIH support	137 (55 %)	177 (58 %)	44 %
Mean age at application ^b		42 years (mean)	44 years (mean)	–
		38 years (median)	42 years (median)	
		Range 25– 60 years	Range 26– 60 years	
Years since degree ^c		5 years (median)	7 years (median)	–
		7.3 years (mean)	11 years (mean)	

* Indicates a field in which data was suppressed due to low (<25) total applicant numbers

^a Individuals in the “dual” degree category hold at least one Ph.D. or at least one M.D., but not both, and at least one “other” professional doctorate (e.g., JD, DDS, VM). Note the small sample in this degree category limits any interpretation of success rate

^b For each application and for each individual, an age is computed if birth date information is available from any of the following sources: IMPACII, AAMC Faculty Roster, or DRF. Age is computed as the difference between the fiscal year of the application and the fiscal year of the individual's birth date

^c For each individual for which degree information was available, along with a date or year of the conferral of the degree, we calculated the years since degree by subtracting the earliest year of any degree found from the fiscal year of the first BRP-SGP award or last unsuccessful BRP-SGP application

Combining data from tiers 2 and 3, a total of 66 distinct fields of study were matched to BRP-SGP applicants. Nearly three quarters of applicants came from 16 of the 66 reported fields with clinical psychology being the most prevalent field of study (*n*=74 applicants) followed by public health (*n*=24 applicants). Figure 2 illustrates the broad spectrum of applicant expertise. Number of applicants is displayed in parentheses for each field of study category with greater than four applicants. Numbers for fields of study with less than five applicants are not included in Fig. 2 to protect confidentiality.

Table 2 shows the top five Ph.D. fields of study for BRP-SGP applicants with Ph.D. or M.D./Ph.D. degrees by funding status. The greatest number of awards went to applicants who earned a Ph.D. in Psychology followed by applicants who earned a Ph.D. in a life science-related field of study, specifically health sciences (i.e., epidemiology, pub-

lic health, and nursing sciences). These data suggest that the program was successful in attracting applicants from a broad range of academic fields.

Goal 2: promote career development of investigators new to the field of behavioral cancer prevention and control
Using the NIH's IMPAC II grant database, subsequent NCI grant application activity was collected for BRP-SGP awardees and non-awardees in both the full and bubble cohorts. Subsequent grant activity was ordered into tiered achievements or “high water mark” categories with each applicant being placed in the category representing subsequent grant activity attained based on NCI application activity through FY 2011 (Fig. 3). The first three high water mark categories represent the successful receipt of a competitive NCI research project grant or career development award. Category 1 included applicants awarded an NCI R01. Category 2

Fig 2 | Aggregated fields of study and their constituent fine fields of BRP–SPG applicants. Box size illustrates proportion of applicants from a given field. Fields of study with no numbers represent <5 applicants

included applicants awarded other non-R01 RPG funding, specifically a second small research grant (R03) or exploratory/developmental grant mechanism (R21). Category 3 included applicants awarded other NCI non-research program grant funding (e.g., career development awards). BRP–SGP applicants were included in categories 4 through 6 if they applied for a NCI competitive research program grant or training award, but were unsuccessful in obtaining an award. Placement in category 7 included those individuals with applications to or awards from NIH institutes other than NCI, and placement in category 8 indicates that no subsequent NIH applications or awards were linked to a BRP–SGP applicant.

For the full cohort of awardees and non-awardees, approximately 35.7 % ($n=88$) of BRP–SGP awardees were included in categories 1–3 and awarded subsequent NCI funding compared to 13.9 % ($n=41$) of non-awardees. Nearly 14 % of the full cohort awardees ($n=34$) were awarded a category 1 subsequent NCI-funded R01. Full cohort awardees were 4.5 times more likely to have received a subsequent NCI R01 than non-awardees ($p=1.16 \times 10^{-5}$, 95 % CI 2.0–10.6).

When employing propensity score matching in which a subset of bubble cohort awardees ($n=92$) and non-awardees ($n=92$) with similar scores were compared, 20 % of both groups were included in categories 1–3 and awarded subsequent NCI funding. The majority of bubble cohort awardees

Table 2 | Top five Ph.D. fields of study by funding status

Ph.D. field of study	Awardees	Percentage of awardees with Ph.D. or M.D./Ph.D. ($n=201$, n -matched = 163 (81 %))	Non-awardees	Percentage of non-awardees with Ph.D. or M.D. ($n=217$, n -matched = 161 (74 %))
Psychology → clinical psychology	56	34.4	18	11.2
Life sciences → health sciences → epidemiology	12	7.4	9	5.6
Life sciences → health sciences → public health	10	6.1	14	8.7
Psychology → social psychology	10	6.1	8	5.0
Life sciences → health sciences → nursing science	8	4.9	10	6.2

Fig 3 | High water mark category rankings for NCI subsequent funding for the full and bubble cohort

were awarded category 1 subsequent NCI R01s. Non-awardees received few category 1 R01 grants and equal proportions of category 2 non-R01 research program grant awards and category 3 other NCI grant awards. Bubble cohort awardees were 4.7 times more likely to have received a subsequent NCI R01 ($p=0.057$, 95 % CI 0.94–46.0).

Pursuit and receipt of subsequent cancer-related research funding from non-NIH sources for the full cohort was also assessed. The overall match rate was very low with only 17 unique applicants from the full cohort matched to 35 awards from ICRP (including DOD CDMRP), 15 applicants matched to 18 awards from the Livestrong Foundation, and 8 applicants matched to 10 awards from NSF. With the exception of the Livestrong Foundation, the majority of matches were to BRP–SGP non-awardees. Propensity score matching methodology could not be applied effectively with such a small sample.

Publications

Of the 542 BRP–SGP applicants in the full evaluation cohort, 384 (71 %) of applicants, including 85 % of awardees (210) and 59 % of non-awardees (174), were linked to 3,205 distinct publications using name-matching algorithms. The odds of being published post-study were 3.9 times higher for awardees than non-awardees ($p=1.75 \times 10^{-11}$). Of those who published, however, awardees and non-awardees published at comparable rates with 1–2 publications per year. The majority of awardee publications were published within the first 3 years following award or application. Average journal impact factor did not differ between the awarded

applicants ($M=3.2$; med 2.5) and the non-awarded applicants ($M=3.4$; med 2.5), $p>.10$.

When employing propensity score matching, 87 % of bubble cohort awardees ($n=80$) and 65 % of bubble cohort non-awardees ($n=60$) were linked to publications. Bubble cohort awardees were 3.5 times more likely to have subsequent publications than bubble cohort non-awardees ($p=0.0009$, 95 % CI 1.6–8.2).

To determine the number of publications specifically resulting from BRP–SGP funding, we searched for publications that acknowledged BRP–SGP funding by listing the award number. To date, 45 % of BRP–SGP projects ($n=114$) were linked to 247 distinct publications.

DISCUSSION

This evaluation demonstrates that the BRP–SGP R03 has been successful in attracting a diverse applicant pool across a broad array of disciplines to the field of behavioral cancer prevention and control research. The NSF's aggregated field of study list served as the basis for a three-tiered visual representation of applicant expertise that demonstrates the breadth of disciplines supporting behavioral cancer and prevention and control research. This representation could serve as a tool to help identify missing expertise in research portfolios, examine funding trends by disciplines, and guide the formation of multi-disciplinary teams needed to address the multi-level, complex behavioral, and psychosocial factors that affect prevention and control across the cancer continuum.

Qualitative findings from the first BRP-SGP evaluation highlighted the importance of the R03 as a mechanism for collecting pilot data to strengthen subsequent grant proposals. NIH traditional research project grant awards (R01) are not limited in dollars and range from 1–5 years in duration allowing investigators the opportunity to conduct comprehensive programs of research. As a result, in this evaluation, subsequent NCI R01 activity was one indicator of success for the BRP-SGP. BRP-SGP awardees in both the full and bubble cohorts were more likely to receive subsequent NCI R01 grants, although it should be noted that the odds ratio for the bubble cohort was not statistically significant. This association may support the notion that the BRP-SGP and resulting pilot data may have given awardees a “leg up” when preparing their R01 application.

Overall, analysis of the differences between NCI subsequent grant awards illustrates that (1) full cohort awardees were awarded more NCI grants across categories 1–3 than their non-awardee counterparts, and (2) bubble cohort non-awardees, while awarded an equivalent percentage of grants in categories 1–3 as their awardee counterparts (~20 %), were awarded NCI grant mechanisms that did not require pilot data (e.g., other RPG awards such as additional R03s, R21s, and non-RPG awards such as training awards). This finding could be interpreted as supporting priority scores as a good metric for identifying PIs with similar potential, and given the similarity in the capabilities of the bubble cohort awardees and non-awardees, the BRP-SGP R03 award may provide an advantage when seeking R01 funding. Of note, applying this methodology did reduce the size of the cohort and thus reduced the statistical significance of some findings.

We had hoped to determine whether there was a pattern of applicants applying to non-NIH funding bodies as a function of R03 award status as there are a myriad of funding sources for behavioral research in cancer control. We were unable to obtain adequate data to answer this question due to the small number of BRP-SGP applicants matched to non-NIH subsequent research applications and awards. Additional study would need to be conducted to determine whether the name-matching algorithm used here requires further refinement to be applied to these data sources, data sources are incomplete, or researchers just did not apply to the organizations we identified in this study. Further, subsequent grant activity at NIH institutes other than NCI was not included in this analysis in an effort to control for a direct relationship to cancer. Although the intent of this evaluation was to determine subsequent cancer-related grant activity, we fully acknowledge the value of using the cancer R03 as a springboard to funded research in non-cancer domains.

Our data on the full and bubble cohorts indicated that awardees were more likely than non-awardees to publish. Our initial assessment of impact factor could also have been strengthened by a more detailed analysis of journals including a more refined text search of the publication and the journal focus itself.

In sum, the BRP-SGP attracted applicants from diverse fields to apply their skills to behavioral research and cancer control and has had a measurable impact on the subsequent research careers of awardees. Specifically, awardees are more likely than non-awardees to pursue and receive subsequent funding from the NCI and publish their research. Text searches on subsequent grant applications and publications would provide more information related to how the R03 award stimulated cancer control research and career development.

The BRP-SGP expired on October 19, 2012 and was essentially replaced by a newly released NCI Omnibus R03 Small Grants Program for Cancer Research (available online at <http://grants.nih.gov/grants/guide/pa-files/PAR-12-144.html> (Note, as per NOT-CA-13-016, PAR-12-144 will expire November 19, 2013. Refer to the successor PAR. Applicants are always advised to carefully check FOAs for requirements and amendments (announced in linked Notices) when preparing and submitting applications.)). The NCI Omnibus R21 Exploratory/Developmental Research Grant Program (available online at <http://grants.nih.gov/grants/guide/pa-files/PAR-13-146.html>) was also recently released and replaced the BRP's former R21 exploratory/developmental research small grant mechanism. Although these mechanisms are broader in focus and do not specifically target new investigators, applications will continue to benefit from a NCI-specialized review and afford the same opportunity to collect pilot data. The NCI's BRP remains committed to fostering the development and retention of investigators new to the field of behavioral cancer prevention and control science.

Acknowledgments: We would like to acknowledge Veronica Chollette (NCI) for her assistance and helpful comments in the preparation of this manuscript. We thank Laure Haak (Open Researcher and Contributor ID, ORCID) and other NCI colleagues who served as members of the BRP-SGP evaluation advisory committee including Kara Hall, Julie Mason, Richard Moser, Lawrence Solomon, and Amanda Vogel for their role and insights during the early stages of this evaluation. We are also grateful to the National Science Foundation, the International Cancer Research Portfolio, and the Livestrong Foundation for sharing their data. This work was supported by contract number HHSN263201000058B and funded with federal funds from the National Cancer Institute, NIH.

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