

Role of non-government organizations in engaging medical students in research

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ABSTRACT

The continued decline in medical trainees entering the workforce as clinician-scientists has elevated the need to engage medical students in research. While past studies have shown early exposure to generate interest among medical students for research and academic careers, financial constraints have limited the number of such formal research training programs. In light of recent government budget cuts to support research training for medical students, non-government organizations (NGOs) may play a progressively larger role in supporting the development of clinician-scientists. Since 2005, the Mach-Gaensslen Foundation has sponsored 621 Canadian medical student research projects, which represents the largest longitudinal data set of Canadian medical students engaged in research. We present the results of the pre- and post-research studentship questionnaires, program evaluation questionnaires of past recipients. This paper provides insight into the role of NGOs as stakeholders in the training of clinician-scientists and evaluates the impact of such programs on the attitudes and career trajectory of medical students. While the problem of too few physicians entering academic and research-oriented careers continues to grow, alternative-funding strategies from NGOs may prove to be an effective approach in developing and maintaining medical student interest in research.

INTRODUCTION

Academic Medicine refers to a branch of medicine that involves a duty to teach the future generation of clinicians, to research and improve our understanding and management of diseases and to provide evidence-based best practice care to patients. Such contributions of academic medicine to the advancement of human health cannot be understated.¹ It is for this reason that governments have invested significant amounts of capital to support academic medical institutions. Clinician-scientists, that is, medical doctors who have undertaken additional training in health research or basic science, play an essential role in academic medicine as they bridge the gap between biomedical research and clinical practice.² By virtue of their dual training and integrated activities, they are well positioned to translate research results into the clinic and to develop questions

based on clinical issues encountered in everyday practice.

Unfortunately, the future of academic medicine in Canada and the USA has come into question as recent reports point to declining numbers of clinician-scientists.^{3–5} Although there has been a rise in the number of MD/PhD trainees in Canada, the numbers ultimately entering the physician-scientist workforce are insufficient.^{6–7} For this reason, there is an increasing need to engage medical students in research.⁸ Past studies have shown that early exposure is successful in generating interest among medical students in research and academic careers.⁹ This is emphasized in a recent meta-analysis,¹⁰ which showed that medical student participation in research is associated with improved short-term and long-term scientific productivity, more informed career choices, and improved interest in and attitudes toward research. Canadian medical schools and training programs, however, were very under-represented in this study. Moreover, the role of non-government organizations (NGOs) in supporting clinician-scientist training was not discussed. In light of recent government budget cuts to support research training for medical students,^{11–12} these NGOs may play a progressively larger role in supporting trainees.

The Clinician Investigator Trainee Association of Canada (CITAC-ACCFC) is a not-for-profit organization established by trainees to strengthen clinician research training programs across Canada. CITAC has played a pivotal role in supporting clinician-scientists, both at the undergraduate level in the form of MD+ programs (MD/PhD, MD/MSc) and residency levels, in the form of Clinician-Investigator Programs (CIP) and Surgeon-Scientist Programs (SSP). Given the evolving needs of Canada's healthcare system, CITAC's mandate is aimed at the collection of data on trainees and alumni to gauge trends in demographics, funding, satisfaction, and outcomes. The ultimate goal of this research is to inform policymakers and stakeholders on how best to sustain and train the next generation of clinician-scientists. In 2013, CITAC published the first document reporting on the basic demographics of Canadian clinician-scientist trainees.^{13–14} The authors captured census data from each training program and highlighted the importance of sustained funding and mentorship.^{15–16} This collaborative

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and national effort is a critical step in understanding the strengths and potential pitfalls of clinician-scientist training programs.

While significant strides have been made to improve mentorship for clinician-scientist trainees in the form of workshops at the CITAC Annual General Meeting,¹⁷ funding for engaging Canadian medical students in academic medicine continues to be an area of substantial concern.^{11 12} The Mach-Gaensslen Foundation (MGF) of Canada functions as one of the country's largest national non-profit summer research training programs for medical students. The MGF in Canada and the Mach-Gaensslen Stiftung Schweiz in Switzerland were established from an endowment of the estates of Mr Vaclav Mach and his wife, Dr Hanni Gaensslen. Both organizations have been operational since 2000 with the primary objective of supporting medical research and specifically in the case of MGF, work in the fields of cardiology, oncology or psychiatry. What started as a trial funding of medical student research at seven Canadian universities has now expanded to include 12 Canadian medical schools. While the MGF summer research grant provides financial assistance to medical students performing research in the fields of cardiology, oncology or psychiatry, the MGF collects additional longitudinal data on participants to determine the role of undergraduate medical research exposure on promoting career choices in keeping with a clinician-scientist. Since 2005, the MGF has sponsored 621 medical students, which represents the largest longitudinal data set of Canadian medical students engaged in medical research. We present the results of the before and after studentship surveys, program evaluation questionnaires, and the 5-year and 10-year follow-up questionnaires of past MGF summer research grant recipients. This paper provides insight into the role of NGOs as stakeholders in the training of clinician-scientists and evaluates the impact of such programs on the attitudes and career trajectory of medical students.

MATERIALS AND METHODS

Participants and data collection

Students attending medical schools partnered with the MGF are notified about the MGF summer research grant through their institution. Each school is provided with a quota of students that will receive funding from the MGF based on the size of the study body. It is up to the individual medical school to determine which students will be nominated for an MGF summer research grant, and therefore all students nominated by the school are generally accepted into the summer research program. All candidates must have the support of a faculty mentor and conduct research in one of three fields including cardiology, oncology or psychiatry. While studentships are generally conducted prior to the third year of medical school (summer after 1st year or 2nd year), the MGF does not have any stipulations as to when the program should be completed. To receive funding, the summer student researcher is sent a letter outlining the terms associated with receipt of the grant. A student agreement must be completed and submitted to the MGF prior to receiving the grant. The MGF also requires that research carried out as a result of the funding meets the ethical requirements of the university's ethical policies. Included in the letter are the following (All grant

forms are also made available on the MGF website (<http://www.mach-gaensslen.ca/grants/students.php#forms>): (1) pre-research questionnaire to be completed and submitted with the student agreement, prior to receiving the grant; (2) post-research questionnaire to be completed and submitted with a research abstract/report at the end of the summer research period; (3) research report—a form to describe the study findings to be completed at the end of the summer research program along with a one-page abstract; (4) program evaluation questionnaire to be completed at the end of the summer research program; and (5) consent for online publication—also to be completed and returned at the end of the research period requesting permission to post the student's name, the name of the research sponsor (faculty member supervising the project) and the subject of the research on the MGF website. Finally, also attached to the letter is a follow-up questionnaire that is to be completed approximately every 5 years.

Questionnaires

The research questions were specifically designed to respond to the study objective: "knowing whether involvement in summer research, while a medical student, will influence career choice or lead to research later in a student's professional life". The baseline (pre-research) questionnaire and the post-project questionnaire are identical in order to measure change in ideas over the period of the student's summer research project. The first two questions are binary in nature—responses being 'yes' or 'no'. The next five questions were designed to allow for latitude in the response by using a five-point Likert scale (1=lowest, 5=highest). A Likert scale is also used in questions distributed to the participants every 5 years following the research project to ask participants on their view of the MGF summer student research program and how it may have affected their medical career. The first question asks which of the three disciplines, as defined by the founders, was the area of their research study. The following eight questions probe more deeply into how they felt the program affected them. Specifically, on a five-point scale ('strongly disagree' to 'strongly agree'), they are asked to rank several statements. Five-year follow-up studies have been carried out for students who were supported in the years 2005–2010 and a 10-year study for the 2005 student group.

Analysis

Data were collected and analysed anonymously. When comparing responses from the questionnaires, we have used an overall percentage based on the total number of students who scored 4 and 5 on a five-point Likert scale, highlighting the percentage of students who were in most agreement with items in the questionnaire.

RESULTS

Participant demographics

Since 2005, the MGF has sponsored 621 medical students, representing the largest longitudinal data set of Canadian medical students engaged in research. Questionnaires were delivered before and after each of the summer research terms from 2008 to 2015. The response rate for the pre-research/post-research survey was 83.7% as 520 students responded to the pre-research and post-research

questionnaires (table 1). Oncology (40.2%, n=209) was the most common research interest, followed by cardiology (36%, n=187) and psychiatry (23.8%, n=124). Interestingly, at the start of the research term, 25.8% (n=134) of participants had not previously completed a defined research project (ie, one that includes hypothesis generation, hypothesis testing, evidence gathering, analysis and conclusions). Of those with prior research experience, 19.4% (n=75) did not participate in a medically related project.

Evaluation of pre-research and post-research term questionnaires

The majority of students indicated participation in medical research to be an important component in the training of medical students (pre-research: 86.5%, n=450; post-research: 87.5%, n=455). Similarly, there was no difference in the pre-research (70.6%, n=367) and post-research (68.5%, n=356) responses as a significant number of students felt that their summer research project generated

significant findings relevant to their field of study. Interestingly, there was a noticeable decline in students who found their summer research topic to be of particular interest on an ongoing basis (pre-research: 91.2%, n=474; post-research: 83.8%, n=436). There was also a decrease in students who expressed an interest in medical research as a full-time career choice after the summer research term (39.8%, n=207) when compared to before (46.3%, n=241). In the event that students did not become full-time medical researchers, 82.0% (n=426) at the start of their research term believed that they would still incorporate medical research as an ongoing component in their clinical practice. Although this number declined to 76.2% (n=396) at the end of the research term, the majority of students were still interested in having a long-term active role in academic medicine.

Program evaluation questionnaire

In order to determine the students' overall experience in the MGF summer research program, a program evaluation

Table 1 Pre-research and post-research survey

Please indicate your research discipline	Cardiology (%)	Oncology (%)	Psychiatry (%)		
	35.96 Yes (%)	40.19	23.85 No (%)		
<i>Pre-research survey (n=520)</i>					
Have you ever carried out a defined research project (ie, one that includes hypothesis generation, hypothesis testing, evidence gathering, analysis and conclusions)?	74.23		25.77		
If 'Yes', was this a study in a medically-related discipline?	80.57		19.43		
	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
To what extent do you feel that the topic chosen for the Summer Student Research Program would be of particular interest to you on an ongoing basis?	0	0.96	7.88	47.12	44.04
To what degree do you believe that carrying out medical research is an important part of a medical student's overall training?	0	1.54	11.92	35.19	51.35
To what extent do you believe that a summer student research project can lead to significant findings relevant to the field of study?	0	5.58	23.85	43.85	26.73
To what extent are you interested in medical research as a full-time career choice?	8.64	15.74	29.37	30.90	15.35
If you do not become a full-time medical researcher, to what extent do you believe that medical research (formal or informal) will be an ongoing part of your medical practice?	0.39	2.31	15.22	43.74	38.34
<i>Post-research survey (n=520)</i>					
Have you ever carried out a defined research project (ie, one that includes hypothesis generation, hypothesis testing, evidence gathering, analysis and conclusions)?	80.96		19.04		
If 'Yes', was this a study in a medically-related discipline?	85.27		14.73		
To what extent do you feel that the topic chosen for the Summer Student Research Program would be of particular interest to you on an ongoing basis?	0.38	3.27	12.50	41.92	41.92
To what degree do you believe that carrying out medical research is an important part of a medical student's overall training?	0.19	2.31	10	37.12	50.38
To what extent do you believe that a summer student research project can lead to significant findings relevant to the field of study?	1.73	6.54	23.27	40.58	27.88
To what extent are you interested in medical research as a full-time career choice?	9.23	23.85	27.11	28.27	11.54
If you do not become a full-time medical researcher, to what extent do you believe that medical research (formal or informal) will be an ongoing part of your medical practice?	0.58	5.38	17.88	34.23	41.92

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questionnaire was completed at the end of the studentship (table 2). The response rate was 79.2–82.0% (n=492–509/621). Given that the MGF summer research term was the first formal medical research experience for a significant number of Canadian medical students, only 58.5% (n=288/492) considered the summer time frame as sufficient for completing a research project. Despite the limited time period, 95.9% (n=488/509) of participants were willing to recommend the program to other medical students. Furthermore, the majority of students found the MGF grant to be of great value to their development as a medical student (95.9%, n=488/509), critical in their personal medical and academic learning objectives (82.3%, n=414/503) and to reflect an appropriate monetary value with respect to their stipend (88.1%, n=446/506). Of note, 52.4% (n=262/500) of participants attributed the MGF research grant as their only opportunity for participating in a medical research project.

Five-year follow-up questionnaire

The long-term benefits of having experienced a summer research term as a medical student was assessed in the form of a 5-year follow-up questionnaire from those having been awarded a grant from 2005 to 2010 (table 3). Ninety-five of the 296 awardees during this period completed 5-year follow-up questionnaires, accounting for a response rate of 32.1%. As expected, the majority of students were residents (92.6%, n=88) at the time of their follow-up questionnaire with 6.3% (n=6) representing full-time clinicians and 1.1% (n=1) representing a full-time academic clinician. For those involved in research, the majority (92.6%, n=88) did not receive funding from external granting agencies, highlighting the need for additional research support among residents. The lasting benefit of having participated in the MGF summer research program was made apparent by 67.4% (n=64) of trainees considering their participation in the summer program to be an important determinant in their decision to pursue a given specialty.

Furthermore, 83.2% (n=79) of respondents deemed involvement in medical research to be an important part of a student's overall training and a valuable learning experience for their current practice.

Ten-year follow-up questionnaire

Given that the majority of Canadian medical residents train in academic environments that promote research, we also conducted a 10-year follow-up questionnaire on a single cohort of participants to assess their involvement in research after entering clinical practice (table 4). Twelve of the 35 students awarded an MGF summer research grant in 2005 completed the 10-year follow-up questionnaires, accounting for a response rate of 34.3%. Interestingly, 41.7% (n=5) of respondents were full-time clinicians with a research component, 33.3% (n=4) were full-time clinicians and 25% (n=3) were medical residents at the time of completing the questionnaire. In contrast to the 5-year survey results, for those involved in research, there was a noticeable increase in the number of participants who received funding from external granting agencies at the 10-year mark (25%, n=3). Furthermore, 58.3% (n=7) of the 2005 cohort of awardees now held faculty appointments, indicating the successful progression of trainees into academic medical careers. Of note, the majority of awardees continued to recognize the importance of medical research participation as an essential component in the overall training of medical students (91.7%, n=11). Given the limited time spent in the summer studentship and the fact that it has been a decade since taking part in the MGF program, only a minority of individuals (33.3%, n=4) considered their MGF summer student research experience to be an important factor in their daily activities. Nevertheless, 58.3% (n=7) of participants still attest to the summer studentship as an important determinant in them choosing to pursue their current clinical interests, with 75% (n=9) of respondents identifying their summer studentship as a valuable learning experience for their currently clinical activities.

Table 2 Program evaluation survey (n=492–509)

	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
The Mach-Gaensslen Foundation provided appropriate information on the foundation and its goals and objectives for this Summer Student Research Program. (n=506)	0.79	2.17	9.09	40.12	47.83
The Student Research Program agreement was clear in the description of the granting criteria and student requirements. (n=507)	0.20	1.18	4.93	39.45	54.24
The summer time frame was sufficient to enable me to complete my research project. (n=492)	5.49	12.8	23.17	31.91	26.63
The Mach-Gaensslen Foundation grant was critical to my personal learning objectives in medicine and in research. (n=503)	0.79	3.18	13.72	35.59	46.72
The amount (ie, dollar value) of the Mach-Gaensslen Foundation grant was appropriate. (n=506)	0.99	0.99	9.88	39.72	48.42
I consider this Summer Student Research Program to be of great value to me as a medical student. (n=509)	0.2	0.39	3.54	19.84	76.03
Without the Mach-Gaensslen Foundation grant, I would not have been able to participate in a summer medical research project. (n=500)	12.4	15	20.2	25	27.4
I would highly recommend the Mach-Gaensslen Foundation Summer Student Research Program to other medical students (n=509)	0.2	0.39	3.54	18.27	77.6

Table 3 Five-year follow-up survey (n=95)

Please indicate your current status	Resident or still in medical training (%)	Full-time researcher with no medical practice component (%)	Full-time researcher with a medical practice component (%)	Full-time medical practitioner with no research component (%)	Full-time medical practitioner with a research component (%)
	92.63 Strongly disagree (%)	0 Disagree (%)	0 Neutral (%)	6.32 Agree (%)	1.05 Strongly agree (%)
Do you believe at this point in time that carrying out medical research is an important part of a medical student's overall training?	2.11	3.16	11.58	47.37	35.79
To what extent do you believe that your Summer Student Research Program experience, as a Foundation grant recipient, was an important factor in encouraging you to enter the type of work you are now doing?	3.16	9.47	20	43.16	24.21
To what degree was your Summer Student Research Program participation a valuable learning experience in your current practice?	1.05	1.05	14.74	45.26	37.89
To what extent do you believe that your Summer Student Research Program experience, as a Foundation grant recipient, is an important factor in how you carry out your current day-to-day activities?	5.26	12.63	43.16	28.42	10.53
	0–10 (%)	11–20 (%)	21–50 (%)	>51 (%)	
How many peer-reviewed papers have you published since your Summer Research Program experience?	93.68	4.21	2.11	0	
	Yes (%)		No (%)		
Do you have a faculty appointment at a university medical school?	10.53		89.47		
If you are doing research, do you receive funding from external granting agencies (NSERC, NGOs, Pharmaceutical firms, etc)?	7.37		92.63		
Are you interested in assisting the Mach-Gaensslen Foundation with future activities?	46.32		53.68		

NSERC, Natural Sciences and Engineering Research Council of Canada; NGOs, non-governmental organizations.

DISCUSSION

In an era where the clinician-scientist continues to be regarded as an endangered species with US data indicating a steady decline in the number of MDs with research-oriented careers from a peak of 4.6% in 1985 to ~1.5% in 2015,^{18–20} additional approaches must be taken to fill the existing gap in translational research. Despite the continued reduced funding of MD/PhD training,^{11 12} there has been an increase in the number of dual-degree holders with 66% of trainees maintaining active research-oriented careers in academic centers and thereby working to address the knowledge-translation chasm that exists between the laboratory bench and patient bedside.²¹ Although there has been limited discussion on the ideal number of clinician-scientists within the medical workforce, we propose a target of 10%, which will double the previous peak in research-oriented clinicians set three decades ago. Given the advances in modern genomics,

bioinformatics, molecular biology techniques and opportunities for large-scale international randomized clinical trials, the opportunities for clinician-scientists are unlike ever before and therefore greater emphasis must be placed on medical administrators and individual academic departments for the development and retention of academic clinicians. With this in mind, the MGF has supported 621 medical students over the past decade through a summer research studentship program with the ultimate goal of building the undergraduate medical research capacity of trainees. The essential role of NGOs such as MGF is undisputable in the current Canadian funding climate, which has withdrawn financial support for the development of clinician-scientists.^{11 12} More importantly, given that most medical students decide whether or not to pursue formal research training prior to entering residency,²² programs such as the MGF summer research grant provide an essential learning

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Table 4 Ten-year follow-up survey (n=12)

Please indicate your current status	Resident or still in medical training (%)	Full-time researcher with no medical practice component (%)	Full-time researcher with a medical practice component (%)	Full-time medical practitioner with no research component (%)	Full-time medical practitioner with a research component (%)
	25.0 Strongly disagree (%)	0 Disagree (%)	0 Neutral (%)	33.33 Agree (%)	41.67 Strongly agree (%)
Do you believe at this point in time that carrying out medical research is an important part of a medical student's overall training?	8.33	0	0	58.33	33.33
To what extent do you believe that your Summer Student Research Program experience, as a Foundation grant recipient, was an important factor in encouraging you to enter the type of work you are now doing?	8.33	0	33.33	58.33	0
To what degree was your Summer Student Research Program participation a valuable learning experience in your current practice?	8.33	0	16.67	58.33	16.67
To what extent do you believe that your Summer Student Research Program experience, as a Foundation grant recipient, is an important factor in how you carry out your current day-to-day activities?	8.33	16.67	41.67	33.33	0
	0–10 (%)	11–20 (%)	21–50 (%)	>51 (%)	
How many peer-reviewed papers have you published since your Summer Research Program experience?	91.67	8.33	0	0	
	Yes (%)		No (%)		
Do you have a faculty appointment at a university medical school?	58.33		41.67		
If you are doing research, do you receive funding from external granting agencies (NSERC, NGOs, Pharmaceutical firms, etc)?	25.0		75.0		
Are you interested in assisting the Mach-Gaensslen Foundation with future activities?	83.33		16.67		

NGOs, non-governmental organizations.

opportunity that exposes students to medical research and thereby fosters their desire for a career in academic medicine.

The success of medical research training programs is illustrated by the overwhelming majority of MGF studentship participants recommending the program to their peers, as well as attributing their involvement to have significant value in their development as a medical student. This is particularly important since half of the participants indicated that without the MGF grant, they would not be able to participate in a summer research project. Furthermore, of the 621 students supported by the MGF, a quarter had no prior medical research experience, highlighting summer research programs as the first and often only opportunity for medical students to participate in research and develop an interest in academic medical careers. While student exposure to medical research is invaluable, the length of such programs is often of limited duration and may be a consequence of available funding, especially in the case of

NGOs such as the MGF single summer research term program. Considering that students' interest in their summer research topic slightly diminished over the course of their term and only a minority of students expressed an interest in medical research as a full-time career choice, extended longitudinal research training programs for medical students may provide opportunities for more comprehensive research immersion. Although only a minority of students were interested in a full-time research career following their studentship, the majority of participants continued to recognize the importance of research in the overall development of a medical student and additionally indicated their ongoing commitment to incorporating research in their future medical practice. Given that a quarter of students in the program had no prior research experience at the start of the term, their willingness to maintain an academic medical practice is a testament to the impact of a single research term throughout one's undergraduate medical education.

The lasting benefit of participating in a research term during medical school was made evident in our 5-year and 10-year follow-up surveys. MGF studentship alumni indicated their research term to be of value to their current clinical practice at both time points and further described their experience as an important determinant in their decision to pursue a given specialty. Of particular concern from the 5-year follow-up survey was the limited external funding available for medical residents engaged in research, despite their continued involvement and interest in research. The need for adequate funding of resident-driven medical research may provide an additional opportunity for NGOs to assist in the training of clinician-scientists whose research interests correspond to the NGO-specific mandates. While research funding was limited among medical residents, the 10-year follow-up survey from a single cohort of MGF participants indicated that over half of the awardees (n=7/12) now held faculty appointments and three-quarters (n=9/12) of those involved in research were able to secure funding from an external agency. Although we did not track the career outcomes of a control group of students who did not participate in the MGF summer program, our outcomes are comparable to graduates from MD/PhD programs, as 52.4–67% of graduates have been shown to hold full-time faculty positions of whom 61–73% have been successful in securing independent funding.^{21 23} Therefore, it is apparent that exposure to medical research during the critical years of undergraduate medical education may truly foster a long-term career in academic medicine.

Despite the recognized importance and value of engaging medical students in research, the current program is not without limitations and caveats pertaining to our data and conclusions. Participant questionnaires are subject to response bias, especially in the case of a low response rate as was observed with our 5-year and 10-year follow-up questionnaires. It is possible that those students who had a favorable experience or chose an academic medical career were more likely to complete our follow-up assessments. Responder bias is not a concern for our pre-/post-research and program evaluation questionnaires as the response rate was 83.7% and 79.2–82.0%, respectively. Given that a control group that did not participate in the MGF studentship was not included in the assessment, it is uncertain whether participants in the MGF program would have pursued an academic faculty position or obtained external research funding without having participated in our program. The short duration of the program also makes it difficult to draw correlations between program involvement and long-term effects. Nevertheless, our long-term follow-up questionnaires yielded responses that supported lasting benefits in the form of medical student research experience influencing subsequent decisions on medical specialties. Moreover, the MGF studentship is limited to those students performing research in the fields of cardiology, oncology and psychiatry. Consequently, not all medical student research interests may be captured through our program and as some institutions may have a limited pool of research mentors in the fields supported by the grant, this may further influence which students are able to participate in a research term. On considering these limitations, the results of our program are only applicable to

those students awarded an MGF summer research grant. Irrespective of these caveats, our results continue to support a positive experience for medical students engaged in research and these findings are even upheld for a decade following participation in the grant program.

The MGF summer research program provides one example by which NGOs may contribute to the development of clinician-scientists. Our data suggest that early exposure to research positively influenced the overall development of medical students, promoted the successful progression of trainees into academic medical careers, allowed students to assess their suitability for a career in academic medicine, and maintained a long-term positive attitude toward medical research. While the problem of too few physicians entering academic and research-oriented careers continues to grow, alternative-funding strategies from stakeholders such as NGOs may prove to be novel approaches that should be included in long-term medical education strategies focused on increasing the number of clinician-scientists.

Competing interests KP, CC, and IA are associated with MGF and provided the longitudinal data sets to members of CITAC (BM, AKD, XW and AK). CITAC members performed all data analysis without influence from members of MGF. BM was a prior recipient of an MGF summer research grant.

Ethics approval Research Ethics Board at all participating home institutions of students participating in the research grant program.

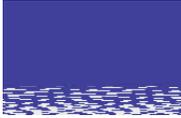
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