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Leadership Roles and Activities Among Alumni Receiving Postdoctoral Fellowship Training in Cancer Prevention

David E. Nelson[1] · Jessica M. Faupel-Badger[2] · Grant Izmirlian[3]

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Abstract

This study was conducted in 2016–2017 to better understand formal and informal leadership roles and activities of alumni from postdoctoral research training programs in cancer prevention. Data were obtained from surveys of 254 employed scientists who completed cancer prevention postdoctoral training within the National Cancer Institute (NCI) Cancer Prevention Fellowship Program, or at US research institutions through NCI-sponsored National Research Service Award (NRSA) individual postdoctoral fellowship (F32) grants, from 1987 to 2011. Fifteen questions categorized under Organizational Leadership, Research Leadership, Professional Society/Conference Leadership, and Broader Scientific/Health Community Leadership domains were analyzed. About 75% of respondents had at least one organizational leadership role or activity during their careers, and 13–34% reported some type of research, professional society/conference, or broader scientific/health community leadership within the past 5 years. Characteristics independently associated with leadership from regression models were being in earlier postdoctoral cohorts (8 items, range for statistically significant ORs = 2.8 to 10.8) and employment sector (8 items, range for statistically significant ORs = 0.4 to 11.7). Scientists whose race/ethnicity was other than white were less likely to report organizational leadership or management responsibilities (OR = 0.4, 95% CI 0.2–0.9). Here, many alumni from NCI-supported cancer prevention postdoctoral programs were involved in leadership, with postdoctoral cohort and employment sector being the factors most often associated with leadership roles and activities. Currently, there is relatively little research on leadership roles of biomedical scientists in general, or in cancer prevention specifically. This study begins to address this gap and provide a basis for more extensive studies of leadership roles and training of scientists.

Keywords Evaluation · Biomedical · Training program · Ph.D.

Introduction

Leadership is a topic of interest in many fields and has been studied extensively for decades [1–6]. Although there are many dimensions of leadership, the ability to influence others to achieve a certain purpose (i.e., social influence that is goal-directed) is a major element defining leadership [4–7]. Many theories, frameworks, and other approaches have been created for explanatory or predictive purposes at different levels, which range from the character traits of individuals to understanding leadership within large organizations, institutions, or political bodies at national or international levels. This diversity of how to examine leadership is not surprising because it is, fundamentally, a complex and multidimensional concept.

Despite the robust literature, most scholarly work on leadership has not been applied to the context of scientific leadership in general, or more specifically, to the leadership roles and activities of scientists. Most of the research on scientists or health care providers has focused on formal leadership, such as those holding positional roles with some type of official authority over staff members in an organization (e.g., director or dean) or occupying an appointed or elected position (e.g., within a professional society). Leadership is closely tied to power [7, 8], and those in formal leadership position have legitimate (or positional) power such that they have the authority to direct others to perform activities, select individuals for

✉ Jessica M. Faupel-Badger
badgerje@mail.nih.gov

[1] Cancer Prevention Fellowship Program, Division of Cancer Prevention, National Cancer Institute, National Institutes of Health, Bethesda, MD, USA

[2] Postdoctoral Research Associate Program, National Institute of General Medical Sciences, National Institutes of Health, 45 Center Drive, Bethesda, MD 20892-6200, USA

[3] Biometry Research Group, Division of Cancer Prevention, National Cancer Institute, National Institutes of Health, Bethesda, MD, USA

positions or roles, enforce organizational rules or policies, etc. Formal leaders usually have reward and coercive power, that is, they can provide positive or negative consequences to others for their behaviors or actions under their direct purview [8].

In contrast, informal leaders are individuals who are not in formal leadership positions but because of their special or unique knowledge (expert power), access to information (information power), or interpersonal skills or personal characteristics (referent power), are able to influence others in goal or direction setting and decision making [8]. Informal leadership is especially common within scientific and health care organizations or teams, and other scientific endeavors (e.g., research projects), where decision making often occurs through group consensus [7, 8]. The number of formal leadership positions or roles within organizations or institutions are necessarily limited, but such is not the case when it comes to informal leadership.

Given the lack of prior research on scientific leadership, we conducted an exploratory research study of individuals who completed postdoctoral research training between 1987 and 2011 in the field of cancer prevention. We obtained data from former postdoctoral fellows across a range of scientific disciplines [9–11]. Participants consisted primarily of PhD-educated scientists who completed fellowships at the National Cancer Institute (NCI) or who received individual NCI postdoctoral fellowship awards and trained at other research institutions.

The two research questions we sought to answer were (1) What were the different leadership roles and activities of scientists in their careers who had completed postdoctoral research training in cancer prevention, and (2) What factors were independently associated with having leadership roles or positions during their careers following postdoctoral training. Leadership roles and activities were examined across four domains we categorized as organizational leadership, research leadership, professional society or conference leadership, and broader scientific or health community leadership. We used regression modeling to examine the potential independent associations of leadership roles and activities with numerous factors, including demographics, time since completing postdoctoral training, scientific discipline, and type of employer.

Methods

Study Population

We obtained self-reported data thorough an on-line survey of individuals who completed postdoctoral training from 1987 to 2011 at the National Cancer Institute (NCI) intramural Cancer Prevention Fellowship Program (CPFP), or who received a Ruth L. Kirschstein National Research Service Award (NRSA) individual-level NCI postdoctoral training grant (F32) and completed fellowship training at research institutions throughout the USA related to cancer prevention. Extensive details about the study design, participants, and survey questions are available elsewhere [9, 10]. Although participants in these two types of postdoctoral programs had different training experiences, all were competitively selected to receive postdoctoral funding support.

Of the 205 CPFP and 362 NRSA/F32 individuals who met eligibility criteria, surveys were completed by 123 CPFP and 146 NRSA/F32 alumni (59 and 39% response rate, respectively). Data were collected anonymously and no individual identifier information was included in the final dataset. Data within certain demographic categories were irreversibly combined (e.g., race other than white) to avoid cell sizes possibly leading to respondent identification.

Survey Questions

Demographic and other types of questions included age group (classified as < 40, 40–49, ≥ 50 years) sex, fellowship cohort based on quartiles (1987–1996, 1997–2001, 2002–2006, 2007–2011), race/ethnicity (White non-Hispanic, some other race/ethnicity), salary (classified as < $100,000, $100,000–$149,999, and ≥ $150,000), type of doctoral degree (Ph.D., other doctoral degree), type of postdoctoral training program (CPFP, F32/NRSA), scientific discipline (specific type and number [classified as 1 or > 1]), current employer (university/research institution, government agency, other employer [health care institution or hospital, foundation or professional association, private company, self-employed]), and length of time in current job position (< 5, 5–9, and ≥ 10 years).

There were 15 questions on leadership covering formal and informal roles and activities, with some questions having a broader scope than others. They were categorized in four domains: (1) Organization Leadership During Career (advanced to a more senior level position, project leader, assumed leadership or management responsibilities, currently manage or lead professionals from multiple disciplines); (2) Research Leadership in the past 5 years (developed cancer research funding initiatives to address knowledge gaps, led or co-led a clinical trial); (3) Professional Society or Conference Leadership in the past 5 years (organized a session or workshop at a professional society meeting, organized a professional conference or scientific meeting, volunteer leadership in a professional society position, elected leadership in a professional society position, chaired a session or workshop at a professional society meeting); and (4) Broader Scientific or Health Community Leadership in the past 5 years (established or appointed to a working group on cancer research; served as an editor of a journal or on a journal review board; served on a national health advisory board, panel, or committee; served on a local health advisory board, panel, or committee). Response

categories for the individual leadership questions were of three types: yes/no, a range from none to 6+ times, or a range from "not at all" to "a very large extent." We classified these responses as never vs. ever to facilitate meaningful analytic comparisons.

Statistical Analyses

We only included currently employed former fellows (n = 254) for this study. R version 3.2.5 was used for all statistical analyses [12]. We initially conducted cross-tabulations of each leadership item by demographics and other variables followed by regression modeling. We performed one-way associations as a first step in model selection and tested using Pearson's chi-squared test or Fisher's exact test if cell sizes were too small. We used multiple logistic regression to model the probability of independent associations for each of the 15 leadership items versus selected correlates initially based on the full list of 12 independent variables described above. Because age and fellowship cohort were so strongly associated, we omitted age from modeling consideration. We also omitted salary because of its near surrogacy for each of the leadership variables. Because respondents could select more than one scientific discipline, we applied dimension reduction to the set of eight scientific discipline choices, which ultimately resulted in two discipline indicators: behavioral/social science/epidemiology vs. all other, and biomedical science vs. all other [10].

To simultaneously address both goals of model parsimony and reproducibility, we conducted group model selection within each leadership domain in the following way. We selected a candidate independent variable into all models within a given leadership domain if it had two or more one-way associations with leadership variables within that domain with a p value < 0.875 divided by the total number of leadership variables in that domain. We selected the constant 0.875 a priori to balance the resulting selection probabilities across the domains because the number of leadership questions per domain varied in size from two to five.

Results

Demographics and other characteristics of participants are presented in Table 1. The majority were ≤ 49 years of age, female, white non-Hispanic, and from more recent cohorts. The vast majority had a PhD degree, and slightly more than half were CPFP alumni. Three quarters indicated biomedical science or epidemiology/public health as a scientific discipline, although many other disciplines were also named. More than half of respondents were employed at universities or other research institutes, and about half had been in their current positions for <5 years.

Table 1 Description of the study population

Characteristic	Percent (N = 254)
Age (years)	
< 40	34.2
40–49	44.7
≥ 50	21.1
Sex	
Male	36.4
Female	63.6
Race/ethnicity	
White, non-Hispanic	78.8
Other	21.2
Postdoctoral cohort	
1987–1996	15.4
1997–2001	28.3
2002–2006	29.9
2007–2011	26.4
Salary	
< $100,000	39.3
$100,000–$149,999	40.1
≥$150,000+	20.6
Degree	
PhD	91.6
Other doctoral degree	8.4
Type of postdoctoral training	
NRSA/F32	44.9
CPFP	55.1
Scientific discipline[a]	
Biomedical science	43.7
Epidemiology	31.6
Medicine	14.5
Physical science	5.4
Behavioral or social science	15.1
Mathematical science	1.5
Nutrition science	7.5
Other	14.2
No. of scientific disciplines	
1	74.7
> 1	25.3
Current type of employer	
University/research institute	57.1
Government	27.2
Other	15.7
Years in current position	
< 5	49.6
5–9	29.1
≥ 10	21.3

[a] Percent total > 100% because respondents could indicate more than one discipline

Table 2 contains frequencies for the four leadership domain items. For Career Organizational Leadership, approximately three fourths had advanced to a more senior level position or served as a project leader, with about one fifth currently managing or leading scientists from different scientific disciplines. Research Leadership roles or activities were relatively uncommon. Organizing a session or workshop at a professional society meeting, and organizing a professional conference or scientific meeting, were the most commonly reported roles or activities for Professional Society or Conference Leadership. Establishing or being appointed to a working group focused on cancer research and serving as an editor or on a review board for a journal were most often indicated within the Broader Scientific or Health Community Leadership domain.

Findings from logistic regression models for the Organizational Leadership and Research Leadership domains are shown in Table 3. Being a part of one or more earlier postdoctoral cohorts was positively associated with three of the four Organizational Leadership items (Note: fellowship cohort had to be removed from the "advanced to a more senior leadership position" regression model because of its near surrogacy with the dependent variable). Those with 5–10 or > 10 years in their current position were more likely to have advanced to a more senior level position, and scientists whose race/ethnicity was other than white were less than half as likely as whites to have assumed leadership or management responsibilities (OR = 0.4, 95% CI 0.2–0.9). Those working in university or research institutes were also less likely to have assumed leadership management responsibilities compared with scientists in settings classified as other. For the Research Leadership domain, those in government were more likely to have developed cancer research funding initiatives or led/co-led a clinical trial, with those receiving CPFP postdoctoral training or having behavioral science, social science, or epidemiology discipline also being more likely to have led/co-led such trials.

Being in one or more earlier postdoctoral training cohorts was positively associated with three of five Professional Society or Conference Leadership items, as was employment in a university/research institute (Table 4). CPFP postdoctoral training was associated with organizing a professional conference or scientific meeting, whereas having a behavioral science, social science, or epidemiology discipline, or having a degree other than a PhD, was associated with volunteer leadership in a professional society position.

For the Leadership in Broader Scientific or Health Community domain (Table 4), being a part of an earlier postdoctoral cohort was positively associated with serving as a journal editor on a journal editorial board and serving on a local health advisory board, panel, or committee. Persons employed in a university/research institute, or government agency, were more likely to have established or be appointed to a working group on cancer research or serve as a journal editor on a journal editorial board. Having a doctoral degree other than a PhD was positively associated with serving on a national or a local health advisory board, panel, or committee, and having a behavioral science, social science, or epidemiology discipline was positively associated with both editorial and national health advisory board service.

Table 2 Leadership roles and activities frequencies by domain and item

Domain and item	Percent ($N = 254$)
Organizational leadership during career	
Advanced to a more senior level position	76.8
Project leader	72.0
Assumed leadership or managed responsibilities	48.0
Currently manage or lead professionals from multiple disciplines	19.7
Research leadership in the past 5 years	
Developed cancer research funding initiatives to address knowledge gaps	18.9
Led or co-led a clinical trial	12.6
Professional society/conference leadership in the past 5 years	
Organized a session or workshop at a professional society meeting	43.6
Organized a professional conference or scientific meeting	33.0
Volunteer leadership in a professional society position	28.3
Elected leadership in a professional society position	16.9
Chaired a session or workshop at a professional society meeting	15.4
Broader scientific/health community leadership in the past 5 years	
Established or be appointed to a working group on cancer research	34.3
Served as an editor of a journal or on a journal review board	32.7
Served on a national health advisory board, panel, or committee	24.4
Served on a local health advisory board, panel, or committee	20.9

Table 3. Characteristics independently associated with leadership roles and activities, by leadership domain and item

Leadership Domain and Item	Characteristic	Odds Ratio (95% CI)
Organization Leadership During Career		
Advanced to a more senior level position	*Cohort*[a]	
	Time in Current Position	
	<5 years (referent)	1.0 (referent)
	5-10 years	2.2 (1.03-4.7)
	10+ years	11.3 (2.6-50.2)
Assumed a role as a project leader	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	1.8 (0.7-4.3)
	1997-2001	3.0 (1.3-7.9)
	1987-1996	10.8 (2.0-59.5)
Assumed leadership or management responsibilities	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	1.2 (0.5-2.9)
	1997-2001	3.6 (1.4-8.9)
	1987-1996	4.5 (1.4-14.4)
	Race	
	White	1.0 (referent)
	Other than white	0.4 (0.2-0.9)
	Employment Setting	
	Other	1.0 (referent)
	Government	0.4 (0.1-1.2)
	University/Research Institute	0.4 (0.3-0.96)
Currently manage or lead professionals from multiple disciplines	None	
Research Leadership in Past 5 Years		
Developed cancer research funding initiatives to address knowledge gaps	*Employment Setting*	
	Other	1.0 (referent)
	Government	4.3 (1.1-16.5)
	University/Research Institute	2.4 (0.7-8.5)
Led or co-led a clinical trial	*Type of Postdoctoral Training*	
	NRSA/F32	1.0 (referent)
	CPFP	5.2 (1.86-15.4)
	Scientific Discipline	
	Some other discipline	1.0 (referent)
	Behavioral/social science or epidemiology	2.9 (1.1-7.8)
	Employment Setting	
	Other	1.0 (referent)
	Government	4.3 (1.1-16.5)
	University/Research Institute	2.4 (0.7-8.5)

[a] See "Results" section for further description of this regression model

Discussion

Our findings are a step forward to help fill the gap in the limited research on alumni of postdoctoral training programs in the sciences, and more specifically on leadership roles and activities of scientists [7, 8, 13–21]. We found that most cancer prevention-trained scientists had some type of organizational leadership role or activity during their careers other than managing or leading professionals from multiple disciplines, but less than one fifth reported research funding leadership in the past 5 years involving clinical trials or developing cancer research funding initiatives. A sizable minority (15–44%) had

Table 4. Characteristics associated with professional society/scientific discipline and broader scientific/health community leadership roles and activities, by domain and item

Leadership Domain and Item	Characteristic	Odds Ratio (95% CI)
Professional Society or Conference Leadership in Past 5 Years		
Organized a session or workshop at professional society meeting	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	1.5 (0.3-7.5)
	1997-2001	7.6 (1.7-33.5)
	1987-1996	6.7 (1.2-7.5)
	Employment Setting	
	Other	1.0 (referent)
	Government	11.7 (1.3-107.0)
	University/Research Institute	8.9 (1.04-75.5)
Organized a professional conference or scientific meeting	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	0.5 (0.2-1.5)
	1997-2001	2.8 (1.1-7.5)
	1987-1996	1.9 (0.6-6.2)
	Type of Postdoctoral Training	
	NRSA/F32	1.0 (referent)
	CPFP	3.0 (1.2-7.5)
	Employment Setting	
	Other	1.0 (referent)
	Government	5.6 (1.8-17.7)
	University/Research Institute	3.1 (1.1-9.0)
Volunteer leadership in a professional society position	*Scientific Discipline*	
	Some other discipline	1.0 (referent)
	Behavioral/social science or epidemiology	2.7 (1.03-7.0)
	Type of Doctoral Degree	
	PhD	1.0 (referent)
	Some other degree	3.0 (1.1-8.8)
Elected to a professional society leadership position	*Employment Setting*	
	Other	1.0 (referent)
	Government	1.8 (0.3-10.1)
	University/Research Institute	6.1 (1.3-29.3)
Chaired a session or workshop at professional society meeting	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	2.5 (0.4-14.2)
	1997-2001	4.9 (0.9-27.4)
	1987-1996	6.9 (1.1-43.7)
	Time in Current Position	
	<5 years (referent)	1.0 (referent)
	5-10 years	3.1 (1.1-8.7)
	10+ years	1.7 (0.5-5.5)
Broader Scientific or Health Community Leadership in Past 5 Years		
Established or appointed to a working group on cancer research	*Employment Setting*	
	Other	1.0 (referent)
	Government	4.9 (1.5-15.6)
	University/Research Institute	3.4 (1.2-9.9)

Table 4. (continued)

Leadership Domain and Item	Characteristic	Odds Ratio (95% CI)
Served as a journal editor or on journal review board	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	3.4 (1.3-9.2)
	1997-2001	4.6 (1.7-12.2)
	1987-1996	4.9 (1.6-15.5)
	Employment Setting	
	Other	1.0 (referent)
	Government	3.3 (1.01-10.9)
	University/Research Institute	4.1 (1.4-12.1)
	Scientific Discipline	
	Some other discipline	1.0 (referent)
	Behavioral/social science or epidemiology	2.9 (1.1-7.4)
Served on a national health advisory board, panel, or committee	*Scientific Discipline*	
	Some other discipline	1.0 (referent)
	Behavioral/social science or epidemiology	3.2 (1.2-8.4)
	Type of Doctoral Degree	
	PhD	1.0 (referent)
	Some other degree	6.8 (2.2, 21.0)
Served on a local health advisory board, panel, or committee	*Cohort*	
	2007-2011	1.0 (referent)
	2002-2006	3.7 (1.1-12.1)
	1997-2001	1.6 (0.5, 5.7)
	1987-1996	3.2 (0.8-12.8)
	Type of Doctoral Degree	
	PhD	1.0 (referent)
	Some other degree	32.5 (7.9-133.3)

roles or activities in the domains of professional society or conference, or broader scientific or health community, leadership within the past 5 years.

Research over many decades, especially among business and other types of organizations [1, 22, 23], has shown that years of experience (often expressed as chronological age) is a strong predictor of having leadership roles or activities, especially formal ones, and postdoctoral cohort is a direct measure of years of professional experience after completing formal education and training. Our finding that being part of earlier cohorts was positively associated with 8 of 15 leadership items in three of four domains, and the positive association of more years in respondents' current positions with advancement to senior level positions or chairing a session at a professional society meeting, strongly suggest that scientists are similar to persons with non-science backgrounds because experience was a strong predictor of leadership attainment or involvement.

Employment sector was independently associated with eight items across all leadership domains), with nearly all being in the positive direction for those in university/research institute or government settings. This may reflect the greater opportunities scientists in these environments for leadership involvement, greater notoriety within the research community, or employer expectations for scientists in these work settings. Scientists in research institution settings who, for example, hold elected positions in a professional society may see this an indication of professional prominence and have greater importance for promotion or career advancement than for those in other types of settings [24].

Our finding of those who were other than white being only half as likely to have organizational leadership or management responsibilities in their careers, even after controlling for many other potential explanatory factors, was especially troubling, and the reasons for this within this population are not known. There is a body of literature conclusively demonstrating that persons who are African-American, Latino, or of other races/ethnicities [25–31], are less likely to have leadership roles or activities in science, especially in formal leadership positions at academic and medical institutions. Although more research about racial/ethnic minority postdoctoral alumni and

leadership is needed, it is clear more extensive and multilevel efforts, including at the organization level, are needed to help ensure that scientists from racial/ethnic minority populations have leadership opportunities.

There is also a large body of literature demonstrating underrepresentation of women in science and medicine leadership positions and roles (as well as many other fields) [30–38], but we did not find an independent association between sex with any of the 15 leadership items examined. The reasons for the absence of such associations in this study are not known. It is possible that the relatively small sample size might have played a factor, or that differences may have been found if other leadership items were examined. It may also be that the field of cancer prevention research and related disciplines such as public health and epidemiology tend to have higher representation of females than other scientific focus areas and, therefore, more females are in leadership positions. Further research would likely provide more definitive answers.

A behavioral science, social science, or epidemiology scientific discipline was positively associated with four items, with three of them involving service positions in the domains of professional or conference leadership or broader scientific or health community leadership, and the reasons for this are unknown. Having a doctoral degree other than a Ph.D. was associated with three leadership items, all of which were in the professional/conference leadership or broader scientific/health community domains. Most respondents in this category had medical degrees, which probably contributed to their greater likelihood of serving on national or local health boards, panels, or committees.

NCI Cancer Prevention Fellowship Program alumni were more likely to have led or co-led a clinical trial, or organized a professional conference or scientific meeting, than scientists completing postdoctoral training at other institutions. This may be a result of CPFP alumni receiving formal training in grant writing and leadership development during their fellowship, or a networking effect from being a part of larger group of fellows training in cancer prevention at the same institution who interacted with each other on a regular basis.

This study had several limitations. Data were based on self-reports and could not be independently validated. Response rates were relatively high for an Internet-administered survey [39, 40], but respondents may have differed from non-respondents in some ways. There was no comparison population of leadership among persons not completing postdoctoral cancer prevention training in competitive programs. Because of the relatively small number of respondents who were of a race/ethnicity other than white and concerns about the potential for identifying individual respondents, we could not disaggregate these data. Survey question recall period and response options were not identical for all items. There were different numbers of survey items within each leadership domain, and only two items for Research Leadership, both of which were narrowly focused.

Leadership in science is a broad topic encompassing many roles and activities beyond those covered in this study; thus, it is possible that findings would have been different if more questions or other questions were used. Cancer prevention is a specialized field, which means the findings may not be generalizable to those who completed postdoctoral research training in other scientific areas nor to the broader scientific research community. Because the CPFP and F32/NRSA programs only accept US citizens and permanent residents, findings may not be applicable to postdoctoral fellows who are foreign nationals and who currently constitute an estimated 60% of the postdoctoral biomedical research fellow population in the USA [14].

The conduct of research in the health sciences has evolved over time. Both formal and informal leadership roles and activities are essential to research advancement, especially now that scientists increasingly work collaboratively as part of interdisciplinary teams [41, 42]. Multiple frameworks for training early career scientists, such as the National Postdoctoral Association's Core Competencies and the Vitae Researcher Development Framework, emphasize leadership prominently among the skills needed to be successful in biomedical science careers [43, 44]. This has subsequently been echoed in career development advice for early career scientists, with numerous universities now offering courses in leadership skills to graduate students, postdoctoral fellows, and junior faculty [45, 46].

Unfortunately, there has been little research on scientific leadership. Having a better sense of the types of leadership roles and activities available to scientists across different career sectors would be informative for those involved in creating and implementing leadership trainings. This exploratory study of cancer prevention postdoctoral fellowship training alumni over a 25-year period can provide some insights, but more extensive research is needed in this, and other scientific disciplines and health fields to gain a thorough understanding of leadership, and effective educational and training approaches, to help improve leadership among individuals, groups, and within organizations.

Compliance with Ethical Standards

Ethical Approval Study design and materials were reviewed by independently by both the National Institutes of Health (NIH) and Westat Institutional Review Boards and deemed the surveys of individual participants exempt under rule 45 CFR 46.101(b)(2).

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