Chapter 5
Summary and Conclusions

Since their inception in 1975, the National Research Service Award programs have aimed to stimulate and foster the preparation of highly qualified and productive research investigators in fields relevant to the advancement of biomedical and behavioral science. To accomplish this, individual and institutional awards are made each year to support the predoctoral and postdoctoral training necessary to launch a successful career in research. As of FY 1997, approximately 8,200 predoctoral and 7,000 postdoctoral fellows and trainees were being supported.

Although NRSA funds sponsor both predoctoral and postdoctoral training efforts in a wide range of health-related disciplines, this report targeted individuals who received support at the *predoctoral* level. Within the larger context of graduate student assistance, these programs are relatively modest in terms of their actual size and allotted resources. For example, in FY 1996, the NIH supported approximately 25 percent of all full-time graduate students in biomedical science programs at doctorate-granting universities, but trainees and fellows accounted for only one third of this group. Its contribution to subsidizing graduate study in the behavioral sciences was considerably smaller; about 4 percent of students in psychology and less than 1 percent in the social sciences were primarily supported by *any* type of NIH funds, including traineeships and fellowships.

At the same time, the NRSA programs have occupied a visible niche within the overall landscape of research training. Not only have prior evaluations indicated that former trainees and fellows embarked on active research careers (e.g., Coggeshall & Brown, 1984; National Institutes of Health, 1986), but these training appointments have often been considered as a sign of distinction. The training grant mechanism also has been singled out as a possible model for how predoctoral training in the sciences should be supported (National Research Council, 1995, 1998).

The last Institute-wide evaluation of the NRSA predoctoral training programs examined trainees and fellows in the biomedical sciences who were graduate students in the 1960s and 1970s. This report provides information on more recent cohorts and individuals trained in fields that have not been previously examined (e.g., the behavioral sciences, nursing, and public health).

Focus and Structure of the Evaluation

The underlying rationale of the NRSA predoctoral programs is that they should: (1) influence the occupational choices of individuals through a variety of ways (attract talented individuals to undertake research study in targeted research areas and lower the costs of acquiring this training through stipends and tuition assistance); and (2) provide students with the best possible training opportunities for future career success as an independent and productive researcher (National Research Council, 1979). By accomplishing these goals, the expectation is that this will help "launch them into productive research careers" (National Research Council, 1994, pp. 90-91).

To assess whether these goals have been realized, this study examined the early progress made by former NRSA predoctoral trainees and fellows on several career outcome measures. Of interest were their educational attainment, pursuit of postdoctoral training, involvement in research-related employment, receipt of NIH and NSF research funding, and contributions to the research literature. The major questions included: (1) To what extent have NRSA predoctoral recipients pursued successful careers in biomedical research? (2) How has their performance compared to fellow Ph.D.s who did not receive NRSA predoctoral training support?

and (3) What role did an NRSA traineeship or fellowship play in explaining any observed differences between groups? Because career decisions and behaviors are typically affected by multiple factors and because of the difficulties associated with linking training support to more distal outcomes (i.e., those that occur several years after training support have ended), the majority of attention was paid to those that occur during the early stages of establishing a research career.

Similar to previous evaluations of the NRSA training programs, existing data sets on the training and utilization of Ph.D. scientists provided the primary information on the career progress of NRSA trainees and fellows and their Ph.D. counterparts who did not receive this type of training support. Of interest were FY 1981-92 Ph.D.s — a group that had not been examined in previous evaluations and who have had sufficient time to begin establishing a research career. The NRSA study group consisted of approximately 12,000 individuals in the biomedical sciences and 2,400 Ph.D.s in the behavioral sciences who had received at least nine months of NRSA traineeship or fellowship support. From the pool of individuals whose Ph.D.s were in the same fields and awarded in the same years as the NRSA recipients, two comparison groups were constructed: (1) those who had graduated from doctoral programs in the same set of departments as the NRSA trainees but who did not receive NRSA support (referred to as the NIH training institution group); and (2) doctoral recipients who earned their degrees in departments with no NRSA training support (the non-NIH training institution group).

Members of the first comparison group were expected to most closely resemble the NRSA recipients inasmuch as they met the same criteria for admission into the doctoral program as the students who received NRSA support, and they were enrolled in many of the same courses, interacted with the same faculty, and completed the same degree requirements. Those who earned their degree in departments with no NRSA training grants, on the other hand, were more likely to have been trained in environments that were more heterogeneous in student selection practices, training foci, and degree requirements. The lower fraction of individuals from top-ranked institutions in this group also suggests that their graduate student experiences – especially those associated with faculty involvement in and the amount of institutional resources devoted to research -- might diverge more from those of former trainees and fellows

Overall Findings

Characteristics of NRSA Predoctoral Training

The NRSA programs are designed to help redress shortages in the supply of biomedical and behavioral scientists working in areas identified as important to the health concerns of the nation. To accomplish this, their priorities and policies center around increasing the accessibility to high-quality doctoral training programs in these areas for talented individuals. The individual characteristics of NRSA predoctoral support for 1981-92 Ph.D.s who were former trainees and fellows are consistent with these overarching program aims. Training occurred in a variety of disciplines relevant to health-related research as represented by the fields in which trainees and fellows earned their doctorates. The majority received their degrees in one of the basic biomedical sciences (68 percent), another 16 percent were trained in a behavioral science discipline, and the remainder graduated from programs in other biological sciences or in the health sciences (8 and 7 percent, respectively). Approximately half were supported by the National Institute of General Medical Sciences, the Institute that has typically provided the bulk of predoctoral training support. Consistent with the emphasis on supporting

individuals during the early years of graduate study, tuition assistance and stipends typically began during the first three years of graduate work.

Although the data on the NRSA training experience itself are limited, what is available suggests that receiving NRSA support carried with it certain distinct features. Not only were NRSA recipients *less* likely to have to rely on certain forms of graduate support that can detract from the time spent on courses and other training activities, but they also were *more* likely to cite a traineeship and/or /fellowship as primary for financing their graduate study. Given that sources of support have been linked to choices consistent with a research career (i.e., postgraduation plans), these results provide an initial sense of how NRSA programs may facilitate the production of biomedical researchers. Furthermore, the rates for completion of the doctorate were high — an estimated 76 percent. These are comparable to those that have been reported for other merit-based, national fellowship programs and students in high-quality doctoral programs and significantly higher than those reported by many departments and schools.

However, there were distinctions between the biomedical versus the behavioral sciences in how support was provided. Greater use was made of the fellowship mechanism by the behavioral sciences (16 percent of the NRSA study group versus 5 percent of that in the biomedical sciences), particularly in terms of supporting underrepresented minorities. The median duration of NRSA predoctoral support also was markedly shorter — a median of 24 months as contrasted to 36 months in the biomedical sciences. This may partly account for the fact that whereas 58 percent of former trainees and fellows in the biomedical sciences cited traineeships or fellowships as the primary source underwriting their graduate study, this was true for only 38 percent of those in the behavioral sciences.

The Ph.D.-granting institutions of former trainees and fellows were, however, considerably more similar for the biomedical and behavioral sciences, clearly reflecting the objective of sponsoring high-quality training. Of every ten NRSA trainees and fellows in biomedical disciplines, eight received their degree from institutions ranked in the top quartile of biomedical science doctoral programs; the corresponding figure for graduating from an institution with top-ranked behavioral science programs was seven. These distinguished doctoral programs often supply substantial numbers of doctorally trained scientists; for example, in some biomedical science disciplines, NRSA support contributed to the training of more than 70 percent of the degrees that were granted from these prestigious institutions.

Early Career Progress of Predoctoral Trainees and Fellows in the Biomedical Sciences

The analyses presented in Chapter 3 examined several indicators relevant to the career achievements of young biomedical scientists. These include: (a) time required to earn the Ph.D.; (b) participation in postdoctoral research training; (c) plans and involvement in research-related employment; (d) application to and receipt of NIH and NSF research grants; and (e) publication productivity. Table 5.1 summarizes the outcomes for selected variables. For each outcome, it reports the observed performance of each group and whether the NRSA trainees and fellows significantly differed from their comparison group counterparts in the desired direction, based on the result of simple (unadjusted) comparisons (as indicated by a "+"). When NRSA predoctoral training support was found to be a significant predictor of an outcome over and above other factors that also might influence performance, a box is placed around the "+". In combination, this information is intended to summarize the major ways in which the NRSA study group differed from either its fellow graduate students or Ph.D.s from departments without NIH training grants *and* whether NRSA predoctoral support helped to explain the nature of this observed difference. In general, the analyses showed:

Table 5.1
Overview of Early Career Outcomes and Group Comparisons in the Biomedical Sciences

Outcome (Ph.D. cohorts of interest)	**Observed Results**			**More Progress on Outcome for NRSA Trainees and Fellows vs.**	
	NRSA Trainees and Fellows	Ph.D.s from NIH Training Institutions	Ph.D.s from Non-NIH Training Institutions	NIH Training Institutions	Non-NIH Training Institutions
Less time (in years) to complete Ph.D. (1981-92)	6.5	6.9	7.0	+	+
Percent who pursued postdoctoral training (1981-90)	77.9	59.9	47.6	+	+
Percent who were working in a research career position in 1995 (1981-88)	87.2	77.2	72.3	+	+
Percent with an academic, tenure-line position	39.3	29.1	32.0	+	
Percent employed by a top-ranked academic institution	37.0	23.4	15.9	+	+
Percent who applied for one or more NIH/NSF grants (1981-88)	46.3	35.0	26.3	+	+
Percent awarded a grant (of those who applied)	66.8	55.0	47.0	+	+
Average number of post-Ph.D. journal publications per individual (1981-82)	12.8	9.7	8.9	+	+
Average citations to published articles per individual (1981-82)	28.5	24.7	18.9	+	+

Note. A "+" indicates that the observed difference (unadjusted) was significant and in the direction where NRSA trainees and fellows outperformed their comparison group counterparts in favorable ways. Enclosing the "+" by a box indicates that NRSA predoctoral support was found to be statistically significant in helping to explain the observed difference, after adjusting for the influence of other variables.

(1) *Time formally enrolled in graduate school.* An NRSA trainee or fellow in the biomedical sciences completed the Ph.D. in less time, spending an average of 6.5 years in doctoral study. This was 4 - 5 months shorter than his or her graduate student counterparts who did not receive NRSA support. After controlling for other factors that can affect degree time (e.g., major field), the contribution of NRSA predoctoral support remained significant, although its contribution was quite small. Those provided with traineeships in the early years of graduate school, however, were significantly more likely to complete the Ph.D. in less time than trainees whose appointments began in their fourth year of graduate study or later.

(2) *Pursuit of postdoctoral training.* Upon receipt of the doctorate, the next step for those with NRSA predoctoral training support was consistent with continued progress toward a research career. Although the nature of this step (postdoctoral study or actual research-related employment) depended on the field of study, it was much more likely that former trainees and fellows chose to acquire additional postdoctoral training. Among 1981-90 Ph.D.s, approximately 78 percent of NRSA predoctoral recipients had moved into a postdoctoral training position within four years of completing their doctorate as compared to 60 and 48 percent of those from NIH and non-NIH training institutions. Greater involvement in NRSA-supported postdoctoral training also was characteristic of predoctoral NRSA recipients who were considerably more likely to have held NRSA postdoctoral appointments (40 percent) than their comparison group counterparts (25 and 18 percent of the NIH and non-NIH training institution groups, respectively). Overall, the results on postdoctoral study translate into noticeable differences, some of which stemmed from the fact that former trainees and fellows were more likely to earn doctorates in fields where postdoctoral training is expected. However, after discipline and other factors were taken into account, the role of NRSA still helped to explain the group differences.

(3) *Employment in research careers.* In general, differences in employment outcomes between former NRSA trainees and fellows and comparison group Ph.D.s were smaller in comparison to those described for postdoctoral training. For example, being in a tenure-line position 7-8 years after completing the doctorate -- a precursor to obtaining external research grant support and actively publishing -- was true of 39 percent of NRSA trainees and fellows, 29 percent of those graduating from the same department, and 32 percent of Ph.D.s from non-NIH training institutions in the 1981-88 cohorts. In general, members of the NRSA study group were more likely to hold tenure-track positions than their counterparts with whom they attended graduate school for most cohorts, but there was no consistent pattern of group differences when contrasting trainees and fellows with those who earned their degrees from departments without NIH training grants.

However, former NRSA trainees and fellows were significantly more likely to hold faculty positions in institutions with distinguished doctoral programs than individuals from either comparison group. Across all cohorts, an estimated 37 percent of Ph.D.s. with NRSA predoctoral support held faculty appointments at institutions ranked in the top quartile of those with doctoral programs in the biomedical sciences, but only 16 percent of those from the non-NIH training institution group were in this status. The percentage for biomedical scientists from the same departments was 23 percent.

Looking at employment in both academic and nonacademic research environments as of 1995, a larger proportion of NRSA-supported Ph.D.s (87 percent) at all career stages were working *research-related* positions than those from departments without NRSA support (77 percent). The proportion of their counterparts from the same departments was roughly similar (72 percent). It was the case, however, that completing postdoctoral training, along with spending less time in graduate school, had the most impact on these employment-related indicators. Controlling for field and other variables , NRSA predoctoral support did not make a noticeable contribution to explaining their greater success on these employment-related outcomes.

(4) *Applications to and awards for NIH/NSF research grants.* Similar to past evaluations of the NRSA predoctoral training programs, those who received NRSA support exhibited stronger performance records in terms of both application and success rates. NRSA predoctoral recipients were more likely to have applied for one or more NIH and/or NSF research grants as of FY 1994. Approximately 46 percent of 1981-88 Ph.D.s with NRSA traineeships and fellowships had submitted one or more applications as compared to 35 and 26 percent of individuals from the same departments or ones without NRSA predoctoral training awards. Factors other than NRSA support (having NRSA or other sponsored postdoctoral training and holding a faculty position) emerged as the significant predictors among the group of variables examined; once these were taken into account, the role of predoctoral support was not statistically reliable.

Having applied, NRSA study group cohorts consistently outperformed both comparison groups in terms of successfully obtaining such research grants. Whereas approximately 67 percent of the NRSA applicant group had received one or more grants, this was true for 55 and 53 percent of the NIH and non-NIH training institution comparison groups. Furthermore, although having a faculty position again predicted the award of funds, NRSA predoctoral support explained an additional variation in performance between trainees and fellows and their fellow graduate students from the same departments. When contrasting the greater success of the study group as compared to Ph.D.s from departments without NRSA training grants, postdoctoral training (both NRSA appointments and other types of mechanisms such as research grants), the reputation of one's doctoral program, and completing graduate school in shorter periods of time served as the best predictors.

(5) *Publications and citations.* Publication activity as examined in two cohorts also was somewhat greater for NRSA predoctoral trainees and fellows. This was particularly true for 1981-82 Ph.D.s. where the average number of journal articles published in the years following the Ph.D. were 12.8, 9.7, and 8.9 for the NRSA, NIH training institution, and non-NIH training institution groups. Similar-sized differences were found in average citation rates. Not surprisingly, this between-group variation in publication activity was partly the product of differences in postdoctoral training and being in an academic, tenure-line position. Taking these and a handful of other variables (e.g., gender and prestige of the doctorate-granting institution) into consideration revealed no additional contribution by NRSA predoctoral support.

In general, the observed group differences indicate that NRSA predoctoral trainees and fellows outperformed Ph.D.s from departments without NIH training grants to a greater extent than they did when contrasting them with Ph.D.s from the same departments. Not surprisingly, however, the groups also differed

with regard to other characteristics that affect career progress and outcomes. For example, postdoctoral training in many biomedical sciences disciplines is a prerequisite for landing an academic job in an institution that values research, and large majorities in many biomedical disciplines spend about four years in postdoctoral study. Academic institutions, particularly those with prestigious doctoral programs, are the employers that most value and reinforce obtaining research grants and publishing in peer-reviewed journals. This was clearly demonstrated by the regression-based analyses where variables associated with postdoctoral training and academic employment emerged as the key predictors of success rates and publication records. Thus, the fact that NRSA predoctoral support still explained a small amount of the observed differences in success rates is worth noting. This is particularly true, given that the time between receipt of NRSA traineeships and fellowships and such outcomes as employment and research funding is lengthy — anywhere from 6 to 10 years if one counts time in graduate school after support ended and postdoctoral study. This limits the likelihood of finding sizable effects that are direct effects of such support.

Having a traineeship or fellowship also helped to explain the increased participation in postdoctoral training by the NRSA study group. Given the host of factors that positively or negatively affect the careers of researchers (e.g., family responsibilities, mentoring by senior scientists, and institutional support), it may be that the most noticeable effects of NRSA predoctoral support are found in these early stages of building a research career. There also was some suggestion that such support may particularly aid in encouraging postdoctoral study and the acquisition of more finely-tuned research skills in fields where such experiences are not the traditional path after graduation.

Early Career Progress of Former NRSA Predoctoral Training in the Behavioral Sciences

In Chapter 4 were described group differences in the early careers of behavioral scientists who had and did not have NRSA predoctoral support. These differences resembled those reported above for the biomedical sciences in terms of the rank ordering of the study and comparison groups on one or more outcome measures. At the same time, they less often translated into meaningful differences. Whether this situation accurately depicts the profile of NRSA-supported behavioral scientists, however, is not completely clear due to the problems associated with the small number of former trainees and fellows for which data on outcomes and other variables were available.

Table 5.2 summarizes the results of the analyses which compared NRSA trainees and fellows in the behavioral sciences with other Ph.D.s who did not receive such support for their doctoral study. They include:

(1) *Time formally enrolled in graduate school.* In general, doctorate completion times have been longer in the behavioral sciences (a mean of 8.0 years for all 1981-92 doctorates). Former NRSA trainees and fellows did, however, complete their degree in less time, taking an average 7.3 years as contrasted with the 8.2 years taken by Ph.D.s from the same departments and 8.0 years by those from the remaining departments. In addition, having an NRSA predoctoral training appointment did exert a small influence on progress in graduate school over and above such other variables as field, having outside employment as the primary source of graduate financial assistance, and transferring institutions between the master's and doctoral degrees. Similar to the results found in the biomedical sciences, those whose trainee appointments were made at some time during the first three years of graduate school were significantly more likely to complete their degrees in less time than trainees whose appointments began in their fourth

Table 5.2
Overview of Early Career Outcomes and Group Comparisons in the Behavioral Sciences

Outcome (Ph.D. cohorts of interest)	**Observed Results**			**More Progress on Outcome for NRSA Trainees and Fellows vs.**	
	NRSA Trainees and Fellows	Ph.D.s from NIH Training Institutions	Ph.D.s from Non-NIH Training Institutions	NIH Training Institutions	Non-NIH Training Institutions
Less time (in years) to complete Ph.D. (1981-92)	7.3	8.2	8.0	+	+
Percent who pursued postdoctoral training (1981-92)	36.8	25.9	19.1	+	+
Percent in a research-related position in 1995 (1981-92)	56.6	53.6	49.4		
Percent with an academic, tenure-line position	48.1	40.2	33.5		+
Percent employed by a top-ranked academic institution	22.7	13.5	9.9		+
Percent who applied for one or more NIH/NSF grants (1981-88)	36.1	22.0	14.9	+	+
Percent awarded a grant (of those who applied)	51.4	45.7	43.5		
Number of journal publications in 1990-95 per individual (1981-90 Ph.D.s)	5.5	4.1	3.1	+	+

Note. A "+" indicates that the observed difference (unadjusted) was significant and in the direction where NRSA trainees and fellows outperformed their comparison group counterparts in favorable ways. Enclosing the "+" by a box indicates that NRSA predoctoral support was found to be statistically significant in helping to explain the observed difference, after adjusting for the influence of other variables.

year of graduate study or later. This also was true of trainees who indicated that a traineeship served as the primary source of support for their doctoral training.

(2) *Pursuit of postdoctoral training.* Although postdoctoral training has traditionally been a less required credential in the behavioral sciences, it was much more common for former trainees and fellows. Whereas 37 percent of those with NRSA predoctoral support went on to acquire additional postdoctoral training, this was the next step for only 26 percent of Ph.D.s from the same departments and 19 percent of those from departments with no NRSA predoctoral training grants. These differences, however, were primarily attributable to field, with psychology doctorates being much more likely to have had postdoctoral training appointments. After adjusting for this and other factors, their greater participation could not be explicitly linked to having an NRSA predoctoral traineeship or fellowship.

(3) *Employment in research careers.* Across all cohorts, the percentages holding an academic tenure-line position and working in an institution known for its high quality doctoral programs in the behavioral sciences were significantly higher for the NRSA study group as compared to Ph.D.s who graduated from departments without NIH training grants. As of 1995, nearly half (48 percent) of NRSA trainees and fellows had such positions as compared to 34 percent of individuals graduating from departments with no predoctoral training grants. The percentage of individuals who graduated from the same programs as NRSA predoctoral recipients and had faculty positions more closely resembled that of trainees and fellows (40 percent).

The academic appointments of the NRSA study group also were more likely to be in institutions with top-ranked behavioral science doctoral programs. Whereas 23 percent were in such universities, this was true of noticeably smaller fractions of the NIH and non-NIH training institution groups (14 and 10 percent, respectively). The fact that only the NRSA/non-NIH training institution difference was statistically significant may be partly a function of small sample sizes in the NRSA group.

(4) *Applications to and awards for NIH/NSF research grants.* Former NRSA trainees and fellows consistently outperformed their comparison group counterparts in terms of submitting one or more applications/proposals for NIH or NSF research grants. About 36 percent of former trainees and fellows had applied to one or both of these sponsors as compared to 22 percent of their fellow graduate students from the same department and 15 percent of those from other departments. This suggests that those whom NRSA funded for their doctoral study may have been more likely to pursue behavioral research on health-related problems – one goal of the NRSA. After taking into account the influence of variables such as postdoctoral training and academic employment, both of which predicted application activity, the role of NRSA predoctoral support significantly explained a small portion of the variance over and above these other factors but only for the NRSA/non-NIH training department comparison.

These differences did not persist, however, when examining the success of applicants. Here, the performance of all three groups was similar – 49, 45, and 42 percent of former trainees and fellows, the NIH training institution group, and those from departments with no NRSA predoctoral training support, respectively, had received one or more grants by FY 1994. The reasons underlying these results are not clear but may be related to an increasingly competitive

funding environment, particularly at the NIMH, and the shifting priorities of Institutes in terms of funding behavioral science research.

(5) *Publications and citations.* Unlike the comparisons performed for the biomedical sciences, it was only possible to look at recent publication counts for doctorates in the behavioral sciences (i.e., the reported number of articles published in or accepted by peer reviewed journals between 1990 and 1995). Once again, these counts were higher for former trainees and fellows, but the differences were small in magnitude and mostly attributable to postdoctoral training and academic employment. Receiving predoctoral training support did not contribute to publication activity once these and other variables were considered.

Overall, the group differences depicted in Table 5.2 again were larger between former trainees and fellows and their counterparts from institutions without NRSA predoctoral training grants than those found between the NRSA study group and other Ph.D.s from the same departments. These involved outcomes for degree completion time, receipt of postdoctoral training, research grant applications, and recent publications. No appreciable differences were found in terms of receiving research support from the NIH and NSF. And although success rates did not appreciably differ, the greater tendency of NRSA predoctoral trainees and fellows to apply may suggest greater interest in establishing a research program in health-related areas. If true, this is not inconsequential, given that the majority of behavioral and social science researchers focus on other types of research areas and problems.

Similar to the biomedical sciences, the group differences that were observed frequently were better explained by other variables (having a faculty position). Whether NRSA predoctoral support actually contributed over and above these other variables remains somewhat uncertain. This is because the much smaller sample sizes, particularly for the NRSA study group, limited the ability to detect meaningful differences. Another potential factor may be the shorter lengths of training support received by predoctoral trainees and fellows in the behavioral sciences. Finally, the available measures may be less sensitive to capturing how the careers of NRSA trainees and fellows diverge from those who did not receive such support (e.g., explicit involvement in health research or the receipt of contracts for applied research on health problems).

What Can Be Said of NRSA Predoctoral Training Support?

As noted in the previous section, the contribution of other factors to the outcomes was examined. The contribution of NRSA support, once these variables were taken into account, typically was small and non-significant. At the same time, although group differences were reduced when such other factors were controlled for, they did not evaporate. This was primarily because the entire set of variables did not go far in explaining differential performance on outcomes.

Two interpretations can be given to these results. On the one hand, the NRSA programs are accomplishing exactly what they intended — fostering the development of high-quality doctoral programs and the number of talented individuals who receive such training. This is reflected in the fact that several variables used in the equations (e.g., reputational ranking of the doctoral institution, receipt of postdoctoral training, and employment as tenure-line faculty in a top-ranked research institution) were also associated with NRSA predoctoral support in the biomedical sciences. That is, earlier analyses showed that NRSA training awards

are typically awarded to institutions with highly ranked doctoral programs. If prestige is related to an outcome (as it is in receiving an NIH or NSF grant) and NRSA predoctoral support is centered in the most prestigious institutions, then it is not surprising that the variable reflecting receipt of a traineeship or fellowship may not have additional explanatory power. Similarly, having additional postdoctoral training was found to be related to academic employment and grant success, and earlier analyses indicated the greater likelihood of NRSA predoctoral recipients pursuing additional postdoctoral study.

Analytically, controlling for these variables reduces the apparent "value added" of NRSA predoctoral support. As Baird (1989) concluded after reviewing the research on the effects of college:

> "Very roughly, the research [on "value added" assessment] indicates that the largest effects on student growth and change are due to maturation, followed by effects due to attendance at any college followed by effects due to attendance at a particular college and, lastly, to effects due to within-college experiences."

In terms of doctoral study and merit-based programs such as the NRSA, one might easily rephrase this sentence to read ". . . the largest effects on career-related growth and change are due to *individual factors such as maturation, motivation, talent, and commitment*, followed by effects due to *being admitted and entering a doctoral program* followed by effects due to *being in a particular doctoral program* and, lastly, to effects due to *within-program experiences such as those supported by NRSA training funds*." Given the competitive process for awarding NRSA predoctoral funding, it is not surprising that proxy variables (e.g., high-quality, research-intensive institutions) could account for the NRSA effect. Also, the available data on NRSA support do little in measuring "within-program experiences" and how they may or may not differ from graduate students supported by other means.

It is heartening to know that a small, residual effect was found in some outcome variables, and not surprisingly, these typically were for those occurring most closely to the receipt of NRSA support. However, reviewing the overall results of the regression models point out that a substantial amount of the variability in outcomes was not explained by the available data. Again, this may be due to the reliance on archival data, which are, in all likelihood, pale surrogates for the complex processes that shape careers.

One interesting observation was the role of NRSA postdoctoral training support in explaining later outcomes, particularly in the biomedical sciences. This has two implications. First, former NRSA trainees and fellows were more likely to pursue postdoctoral training even when field and other variables were held constant. They also were more likely to receive NRSA-funded postdoctoral training, which was found to significantly influence certain outcomes of interest. This greater participation in postdoctoral training may essentially be an important product of NRSA predoctoral support. Second, because some fraction of each comparison group also had NRSA postdoctoral training appointments, this involvement may also have improved their later progress in building a research career. As such, this may have diluted the magnitude of the observed differences between predoctoral trainees and fellows and their comparison group counterparts or even contributed to no-difference findings. Unfortunately, for many outcomes, the sample sizes were too small to permit further subgroup comparisons.

Given the recent interest in the training grant as a model for scientific training, the interest in learning what types of training support work best (National Research Council, 2000; National Science Foundation, 2000), and the recommendation of the National Research Council (1998) that the use of training grants and

fellowships should supplant research assistantships, it would have been beneficial if the results presented in the previous chapters would have unequivocally identified the superiority of the NRSA training programs in producing biomedical investigators over other forms of federal support. Although the pattern is that NRSA trainees and fellows outperformed, in varying degrees, Ph.D.s who did not receive such support, the findings fall somewhat short of providing definitive answers as to whether NRSA traineeships and fellowships are more effective than other forms of graduate assistance. As previously noted, such limitations may be endemic, given the cost of collecting the necessary longitudinal data on a large-scale — the amount which might well consume a sizable fraction of the NRSA program budget

Thus, the question surfaces "What useful information is offered by this assessment?". First, the data presented on the progress of former NRSA trainees and fellows through their doctoral training and in the early career parallels the findings of previous evaluations, indicating that the programs and individuals selected by the NIH peer review system have continued to produce individuals who go on to actively pursue research careers. Second, although the comparisons with Ph.D.s who did not receive such support did not allow the confident identification of the relative effects of NASA predoctoral support), they nevertheless can serve as bases for judging the performance of NASA recipients themselves, taking factors known to influence career paths such as degree field, reputation of the doctorate-granting institution, and additional postdoctoral training into account. Third, the examination of time-to-degree differences among the NRSA trainees themselves and relating this to characteristics of their NRSA support identified one practice that may foster degree progress. It also sheds some light on how traineeships in general may facilitate graduate education over other support alternatives (e.g., providing full support during the early years of graduate study so as to allow individuals to focus on course demands rather than those imposed by research grant deadlines).

Another area that can be informed by this assessment concerns which evaluation questions demand attention in the future. By most measures, the NRSA predoctoral programs appear to be achieving their intended outcomes, although a direct causal linkage cannot be established. Whether the latter is a reasonable goal, given the complexity of careers, difficulties in measurement, and the time required for them to evolve, is questionable. At the very least, it would require substantial and intensive primary data collection. Given the variables that must be incorporated, the importance of subgroup analyses (e.g., field), and the necessity of appropriate comparison groups, this would be a serious undertaking. Given available resources, what may be more instrumental is to shift attention from causal interests to tracking a core set of outcomes well and identifying what training practices are associated with enhanced performance for a sample of NRSA recipients. If highly successful training programs and less successful ones can be identified, obtaining data on how they differ in terms of training experiences and practices could target potential "best practices" for providing high-quality training in the biomedical sciences. In fact, more complete and easily retrievable information on outcomes for all NRSA trainees and fellows by itself would improve program monitoring and assessment.

Given the advent of several shifts in the biomedical graduate education and research enterprise in the early 1990s (National Academy of Sciences, 1998), some may be persuaded to question the generalizability of these findings to more recent cohorts. Obviously, the answer must lie in the future when sufficient time has passed to systematically examine the data of recent cohorts' career experiences. Outcome evaluation, by its very nature, is retrospective in terms of measuring behaviors that were expected to have occurred after participation in the program of interest, and the time required to launch research careers exacerbates this problem in terms of the NRSA training programs. Thus, the utility of these findings to specific career paths in the future (e.g., faculty employment) cannot be presently known. At the same time, many essential components of doctoral training have changed little and will continue in the future. As such, the implications

of the structure of the NRSA training grants and fellowships may have a longer half-life in terms of their relevance for fostering the training of investigators engaged in health-related research.

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