Chapter 1
An Overview of the NRSA Predoctoral Training Programs and Their Evaluation

The year 2000 marked the twenty-fifth anniversary of the National Research Service Award (NRSA) training programs and their implementation. Established by the National Research Service Award Act of 1974 (P.L. 93-348), these programs were conceived as setting a new direction in federally sponsored research training (National Institutes of Health Task Forces for the Review of NIH Biomedical Research Training Programs, 1989; National Research Council, 1994). Although research training had been supported by the National Institutes of Health (NIH) since 1930, funds were now to be targeted at training investigators (as opposed to health professionals) and channeled explicitly to those fields in which there was an *identified need* for biomedical and behavioral research personnel.

Since 1975, the NRSA programs have primarily supported predoctoral and postdoctoral training in a wide range of health-related disciplines. Two types of awards are made: (1) *institutional training grants* to public and nonprofit private institutions for multidisciplinary training programs or targeted training in specific research areas; and (2) *fellowships* to individuals for supervised study with a senior scientist. Recipients of both types are selected on the basis of competitive peer review. Over time, the NRSA programs have evolved to the point where nearly 16,000 students and fellows were supported at either the predoctoral or postdoctoral level in FY 1998.

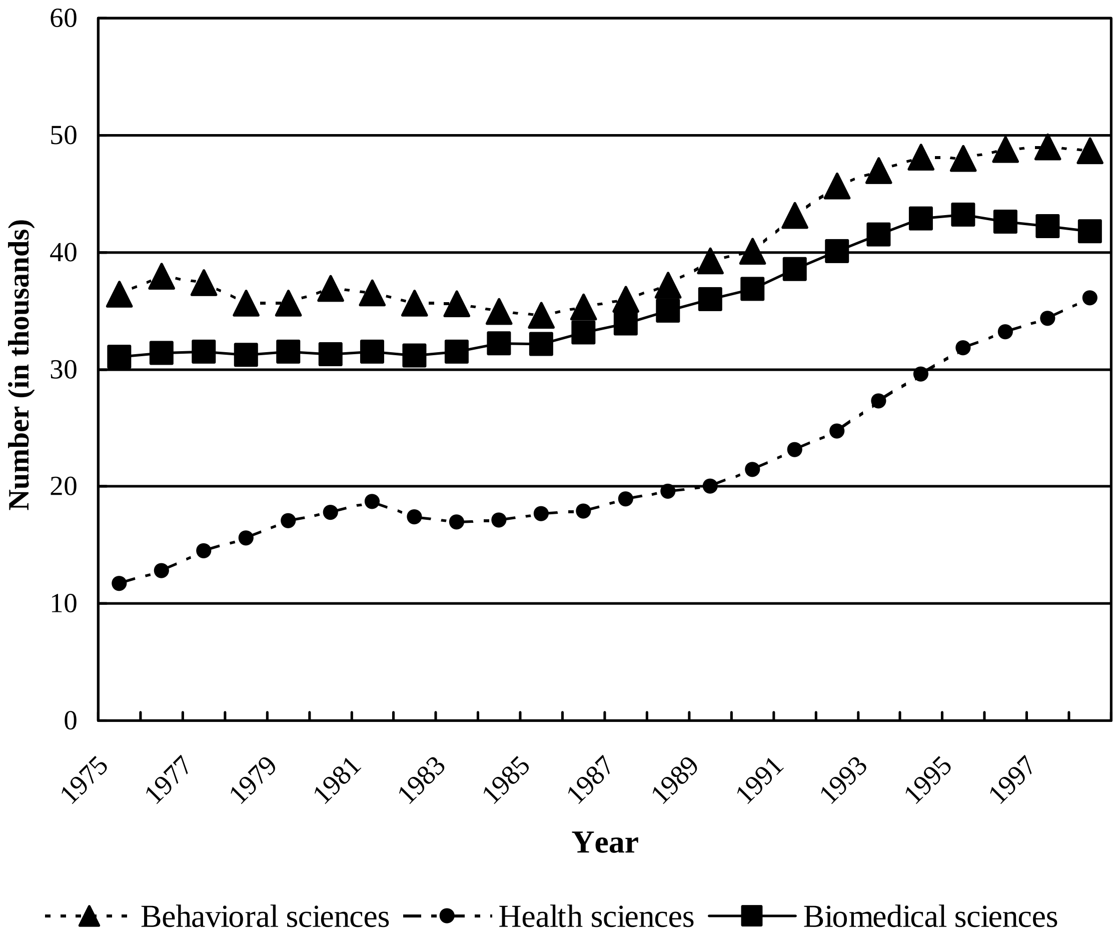
This report examines the characteristics of former NRSA *predoctoral* trainees and fellows and their early progress in pursuing biomedical and behavioral research careers. It then compares their progress to those of individuals who did not receive such support for their graduate study. The last such assessment of NIH predoctoral trainees and fellows in the biomedical sciences was conducted in 1984 (see Coggeshall & Brown, 1984). Since that time, selected outcomes, typically focusing on receipt of NIH research grants, have been examined for NRSA recipients overall and for specific Institutes (e.g., National Research Council, 1994; Velletri, Sherman, & Bowden, 1985). More comprehensive studies have been conducted for a few programs such as the Medical Scientist Training Program and specific training grants funded by this program (e.g., Bradford et al., 1996; Frieden & Fox, 1991; McClellan & Talalay, 1992; National Institute of General Medical Sciences, 1998). For the behavioral sciences, no Institute-wide assessment has been conducted, although levels of funding and support for behavioral science research training have recently been examined (Center for the Advancement of Health, 1999). In previous years, specific Institutes occasionally reported on the NIH grant-related activities of their trainees and fellows (e.g., Clouet, 1986).

The current study looks at several outcomes pertinent to the initial stages of establishing a research career for both biomedical and behavioral science doctorates who received NRSA predoctoral traineeships and fellowships and completed their degrees between 1981 and 1992. Similar to previous efforts, it relies on extant data relevant to the training and utilization of Ph.D. scientists. The purpose of this chapter is to provide a brief overview of the NRSA programs and how their policies have changed over time. It then summarizes the logic behind the evaluation, choice of comparison groups, outcomes of interest, sources of data, types of comparisons, and nature of the analyses.

An Overview of the NRSA Predoctoral Training Programs

Compared to the 1970s, the graduate training enterprise in science and engineering is now considerably larger in terms of programs, faculty, and students. For example, the pool of full-time students at doctorate-granting institutions rose by 2 percent, on average, each year between 1975 and 1994 (National Science Foundation, 1998). For those fields that have been the traditional recipients of NRSA predoctoral training funds, the fastest growth occurred in the late 1980s and early 1990s. Between 1984 and 1994, the biomedical sciences increased, on average, about 3 percent each year, and the behavioral sciences rose by nearly 4 percent annually. The strongest growth occurred in the health sciences, which grew by an average annual rate of almost 6 percent.

Figure 1.1
Full-time Graduate Enrollments in Doctorate-Granting Institutions in the Biomedical, Behavioral, and Health Sciences: FY 1975-98



Note. Data are from the National Science Foundation (2000).

However, the picture has been more mixed in recent years (see Figure 1.1). Between 1995 and 1998, only the health sciences continued to grow, with enrollments rising at an annual average rate of 5 percent. In contrast, the number of full-time graduate students in biomedical sciences programs slowly inched downward, dropping by about 1 percent each year. Nearly all disciplines had fewer full-time enrollments in 1998 than three years earlier, with declines ranging from 2 percent in anatomy, biology, and pathology to 17 percent in zoology. Only cell biology, genetics, and biomedical engineering experienced increases.

In the behavioral sciences, total graduate enrollments remained relatively stable. However, there were distinct differences among disciplines. Whereas the speech and hearing sciences experienced growing student populations (an increase of 13 percent between 1995 and 1998), the number of graduate students in both sociology and anthropology actually declined by nearly 6 percent. In psychology B the largest discipline in this group, enrollments in graduate programs did not change noticeably. Furthermore, the majority of students in this discipline continued to be in those areas that train clinical providers.

How graduate students finance their doctoral study also has changed. In doctorate-granting institutions, the share of full-time students who relied primarily on research assistantships increased from 22 to 28 percent between 1980 and 1998 (National Science Foundation, 2000). At the same time, the percentage supported by trainee ships declined from 7 to 5 percent, and the proportion on teaching assistantship went from 23 to 20 percent. In 1998, research assistantships were the primary source of support for 41 percent of graduate students in the biomedical sciences but only 13 percent for both students in the health sciences and those in the behavioral sciences. Traineeships, such as those provided by the NRSA programs played a much smaller role, particularly in the behavioral sciences; whereas 12 percent of students in the biomedical and health sciences were primarily supported by traineeships, only 4 percent of those working on doctorates in the behavioral sciences held such awards.

The specific contribution of the NIH to their graduate studies also depends on the field. For example, the NIH was the primary source of support for approximately 25 percent of graduate students in the biological sciences as compared to a much smaller proportion (4 percent) of graduate psychology students in FY 1998. In most cases, these students were RAs on NIH research grants. According to the National Science Board (2000), about two-thirds of the graduate students with RAs in the biological sciences were supported by NIH grants in 1997; the corresponding figure for the health sciences was 75 percent. Not surprisingly, given the distribution of research funds across disciplines, the NIH played a lesser role in psychology, sociology and anthropology. About 56 percent of psychology graduate students with RAs were funded by NIH research grants; for graduate students in sociology and anthropology, the fractions were much smaller (36 and 28 percent).

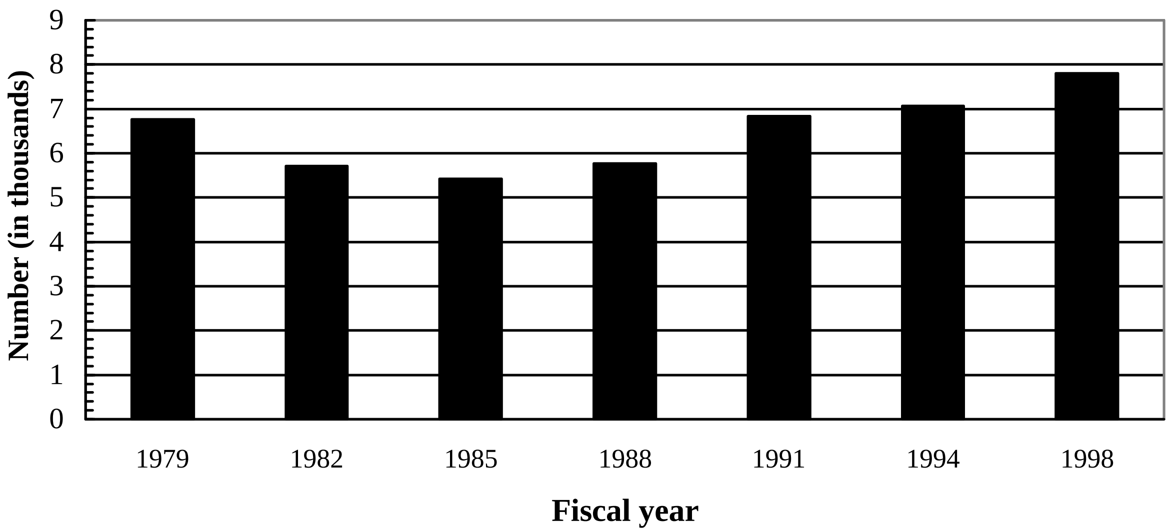
Thus, NRSA predoctoral support occupies a visible but reasonably circumscribed niche in the larger landscape of graduate student support. At the same time, as described in Chapter 2, those individuals who received NRSA predoctoral training support have regarded it as instrumental in financing their graduate studies.

Basic Features of the NRSA Predoctoral Training Programs

Signifying Congressional endorsement for federal investment in research training, the NRSA=s enactment was at least a partial response to the threatened elimination of research training by President Nixon in his budget submitted to Congress in 1975. However, this affirmation has not always manifested itself in terms of actual budget appropriations. During the NRSA=s earliest years, the program continued to be targeted by the Administration for possible elimination, thus, resulting in relatively slow growth between 1975 and 1984. Although funds have risen nearly every year since then, the realized increase in spending power, adjusting for inflation, has been fairly small. For example, approximately $509 million was obligated for research training in FY 1992 B an amount that was 46 percent higher than the funds obligated in FY 1992. Adjusting for inflation, however, reduces this increase by more than half B to 16.5 percent. This represents considerably smaller growth, particularly when taking into account that the majority of the increase was spent on bringing trainee and fellow stipends to more competitive levels and that funds for NIH extramural research grants (adjusted for inflation) increased by 27 percent during this same time period. Also, research training accounted for about 4 percent of the NIH extramural award budget in 1999. This figure is less than the 5.75 percent recommended by an Institute of Medicine Advisory Committee a decade earlier (Institute of Medicine, 1990).

Because students can be supported for up to five years, the number of individuals supported each year was considerably greater, averaging around 5,900 between FY 1990-94. Not surprisingly, given the small increase in constant dollars for these programs, the pool has not grown dramatically since 1981 (see Figure 1.2). During the early 1980s, the number of predoctoral trainees and fellows supported each year actually inched downward, decreasing by nearly 18 percent to a low of approximately 5,300 in 1986. It subsequently recovered to the point where nearly 7,800 individuals were receiving support in FY 1998. At the same time, this figure was only 15 percent larger than the number supported in 1979 B nearly two decades earlier.

Figure 1.2
Numbers of Individuals Receiving NRSA Predoctoral Support: FY 1979-98



Note. Data are from the NIH Trainee-Fellow File and the Office of Research Training at the NIH and include individuals with F30, F31, and T32 appointments.

The NRSA predoctoral programs provide two types of training support. The large majority (about 80 percent) of training funds are for *training grants*; these are awarded to institutions that then select individual students to receive support. Training grants (known as T32s) mainly support graduate students in acquiring broad, multidisciplinary training in biomedical, health, and behavioral sciences research. They also are used to develop research skills needed to investigate a particular disease or organ system (National Institutes of Health, 2000).[1]

The second group of awards (F31s) B *individual fellowships* B supports supervised research training and Ahands-on@ experience for students to work on a specific problem, often their dissertation research. Individual applications are reviewed and award decisions made by NIH scientific review groups. In this way, they resemble the traditional Aportable@ fellowship programs administered by the NSF and some private foundations.

Changes in NRSA Predoctoral Policies and Practices

Although diverse in the disciplines, institutions, and activities that are supported, the NRSA predoctoral programs share a core set of policies governing their operation and functioning. These involve guidelines on participant eligibility (i.e., U.S. citizens and permanent residents), the types of training supported, stipend levels, length of support, and appropriate use of funds. As with any program, some policy changes have occurred since the programs were first implemented, many in response to improving the recruitment and retention of participants, streamlining program administration, and addressing the need for biomedical and behavioral investigators in particular research areas.

The use of the fellowship mechanism. Although training grants have long comprised the largest portion of NIH research training awards as a way of ensuring high quality research training capacity, the fellowship had been the training mechanism of choice throughout the 1950s (National Research Council, 1976b).[2] Beginning in the 1960s, it was essentially replaced by the training grant, and the percentage of predoctoral fellows declined to 9 percent. By 1975, this fraction had further dwindled to about 3 percent (National Research Council, 1976a). In the 1990s, however, other NIH institutes re-initiated the fellowship mechanism to target research training opportunities at special populations, i.e., minorities and individuals with disabilities. This resulted in greater use of the fellowship; for example, the percentage of predoctoral recipients who held fellowships was 8 percent in FY 1994. The most frequent use of the fellowship has been by the three former Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) Institutes (the National Institute on Alcohol Abuse and Alcoholism, the National Institute of Drug Abuse, and the National Institute of Mental Health), the National Institute for Nursing Research, and related programs of the National Cancer Institute (e.g., oncology training programs for nurses).

Targeted level of training. With the exception of a small number of grants for undergraduate programs to increase minority research participation (the Minority Access to Research Career and Career Opportunities in Research training grants), NRSA traineeships and fellowships are targeted at graduate and postdoctoral training. Depending on the needs of individual fields, the extent to which the NIH has directed

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[1]These include the awards made by the National Institute of General Medical Sciences (NIGMS) through its Medical Scientist Training Program for M.D./Ph.D. training. Training grants also are awarded to help support (1) honors undergraduates at minority institutions under the Minority Access to Research Careers (MARC) and the Career Opportunities in Research (COR) programs and (2) health professional students during the summer to become exposed to and interested in health-related research careers. However, these two latter groups of training programs are not examined in this report.

[2]The original NRSA legislation, in fact, specified that at least 25 percent of the total predoctoral and postdoctoral support provided should be allocated to fellowships. However, this fraction has declined over the years to approximately 15 percent.

resources to doctoral versus postdoctoral study has varied. For example, the majority (88 percent) of training grants sponsored by the NIGMS in 1997 supported the graduate training of Ph.D.s and M.D./Ph.D.s in the basic biomedical sciences. In contrast, 84 percent of those funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases were targeted at postdoctoral training.

Since its inception, some shifts in the allocation of NRSA funds for predoctoral versus postdoctoral training have occurred. In the late 1970s, 61 percent of all NRSA training appointments in the biomedical sciences and 76 percent of those in the behavioral sciences were for predoctoral study (National Research Council, 1980). Stemming from a concern over the increasing difficulty in obtaining permanent faculty positions, the National Research Council recommended that some fields shift their attention to providing more opportunities for postdoctoral training and Aretooling.@ Consequently, the fraction of 1983 predoctoral appointments declined by 9 percentage points in the biomedical sciences and 28 percentage points in the behavioral sciences. Partly in response to estimates produced by more recent models of supply and demand, predoctoral trainee and fellow appointments in the behavioral sciences regained some ground, comprising 65 percent of 1993 NRSA appointments (National Research Council, 1994).

The maximum duration of support. In 1975, individual trainees and fellows were limited to a maximum of three years of NRSA predoctoral support without special approval by the Secretary of DHEW.[3] Based on a concern that this stipulation dissuaded individuals from accepting predoctoral support (preferring to be eligible for support at the postdoctoral level), this limit was raised to five years only a few years after the program=s establishment (Biomedical Research and Research Training Amendments of 1978).[4] Despite this modification, the typical duration has remained three years for students in doctoral programs and five years for those working toward a dual-degree.[5]

The Afinancial package@ of support. The NRSA awards provide assistance to both individual students and the institutions sponsoring their training. Typical ingredients of this package include a stipend, tuition support, and an allowance to help defray other costs related to research training (e.g., supplies, travel to scientific meetings, and health insurance). In FY 1975, the annual stipend totaled $3,000, along with a dependent allowance of $600 per month (where applicable). The amount provided for other relevant expenses of trainees was dictated by the overall institutional award (up to 25 percent of the amount of the total award).

The dependent allowance was eliminated in the early years of the program, and the amount available for related training costs was reduced from $3,000 to $1,500 per individual trainee or fellow due to fiscal constraints. Funds for institutional activities, which were judged as important for improving training by supporting faculty to develop interdisciplinary programs and purchase research equipment and supplies, have become extremely limited. As shown in Figure 1.3, the size of the annual stipend has risen slowly. As late as 1998, it was $11,496 B an amount that reflected, in fact, a loss when inflation is taken into account.

Although it is recognized that NRSA predoctoral stipends have not been competitive, increasing stipend levels, while still maintaining the current number of students supported, has been difficult due to limited increases in the appropriations for NIH research training. Exacerbating the problem has been the need

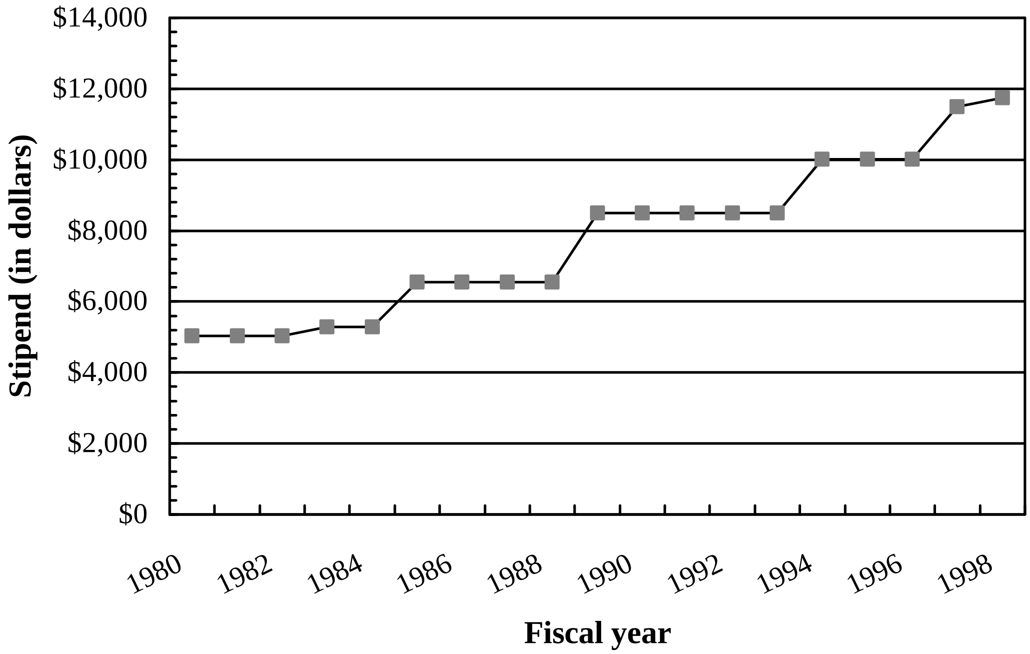
[3]This did not apply to those supported in dual-degree (M.D./Ph.D.) programs.

[4]Students pursuing both the M.D. and the Ph.D. can be supported for up to six years.

[5]The NIGMS actively encourages programs to limit appointments as trainees to three years.

to keep pace with rises in tuition and associated training costs. Such competing demands resulted in many Institutes periodically freezing tuition allowances in order to avoid reducing the number of trainees supported (National Institutes of Health Task Forces for the Review of NIH Biomedical Research Training Programs, 1989).

Figure 1.3
NRSA Predoctoral Stipend Levels: FY 1980-1998



Note. Data are from the Research Training Office, National Institutes of Health.

More recently, one overall cross-Institute response was to establish tuition reimbursement levels. For each trainee, the training grant, on an annual basis, covers 100 percent of the first $2,000 of the combined cost of tuition, fees, and self-only health insurance and 80 percent of any cost above this amount. Stipends also have experienced a substantial rise. In 1999, predoctoral stipends increased by 25 percent to $14,685. This action markedly narrowed the gap between NRSA stipends and those offered by the predoctoral fellowship programs of the National Science Foundation ($15,000) and the Howard Hughes Medical Institute ($16,000). It should be kept in mind, however, that this amount is only 12 percent higher than the stipend paid in 1980 when inflation is considered.

The payback requirement. Another major modification has been the elimination of the payback requirement. For nearly the first 20 years of the NRSA=s operation, predoctoral trainees and fellows were required to Apay back@ their research training support by spending an amount of time in research, teaching, and other related pursuits that was equivalent to the number of months they received predoctoral training support. In 1993, this payback provision was eliminated with the passage of the NIH Revitalization Act of 1993.

Summary. The more recent changes described above (i.e., those regarding payback and the increase in stipends) have no impact with regard to the 1981-92 Ph.D. cohorts examined in this report. At the same time, other practices such as shifting attention to postdoctoral training, reductions in institutional allowances, and noncompetitive stipends may possess some contextual relevance. Although their relationship to career outcomes is far from clear and the necessary data to examine them are not available (e.g., identifying those who did not accept traineeships or fellowships for specific reasons such as more attractive offers from other sources), it should be recognized that they may have influenced the types of individuals receiving and not receiving NRSA support, the fields of study that they pursued, and the length of their NRSA appointments. These, in turn, play some role in the extent to which the NRSA programs can accomplish their overall goals in attracting talented individuals into biomedical and behavioral research.

Completion of the Doctorate

The NRSA predoctoral training programs are designed to provide the training necessary to earn a research doctorate. Thus, comparing the degree completion of NRSA trainees and fellows with those who did not receive such support on degree completion is important. However, although data are available for determining which NRSA recipients earned the Ph.D., comparable information does not exist for individuals who did not receive such support. This is because the large-scale surveys of graduate students, similar to those conducted for scientists and engineers, have not been conducted.

At the same time, it is useful to examine the extent to which former trainees and fellows successfully completed their doctoral training. Overall, an estimated 76 percent of NRSA predoctoral trainees and fellows received their doctorate within five years of their last year of NRSA support.[6] These findings are consistent with those reported by previous evaluations of NIH-sponsored training (e.g., Coggeshall & Brown, 1984). They also mirror the completion rates found for graduate students who were funded by other types of extramural fellowship programs in the sciences. For example, 74 percent of the individuals who received stipends from the Medical Research Council of Canada during the 1970s earned their doctorate (Medical Research Council, 1989). For the fellowship program administered by the National Science Foundation, between 60 and 65 percent of NSF fellows who entered graduate programs between 1962 and 1976 completed their degree (Bowen & Rudenstine, 1992); the corresponding figure for the 1977-81 cohorts was 74 percent (Baker, 1994).[7]

Depicted in Figure 1.4 is the relationship between length of predoctoral support and degree completion for NRSA trainees and fellows whose support ended between 1979 and 1987.[8] As can be seen,

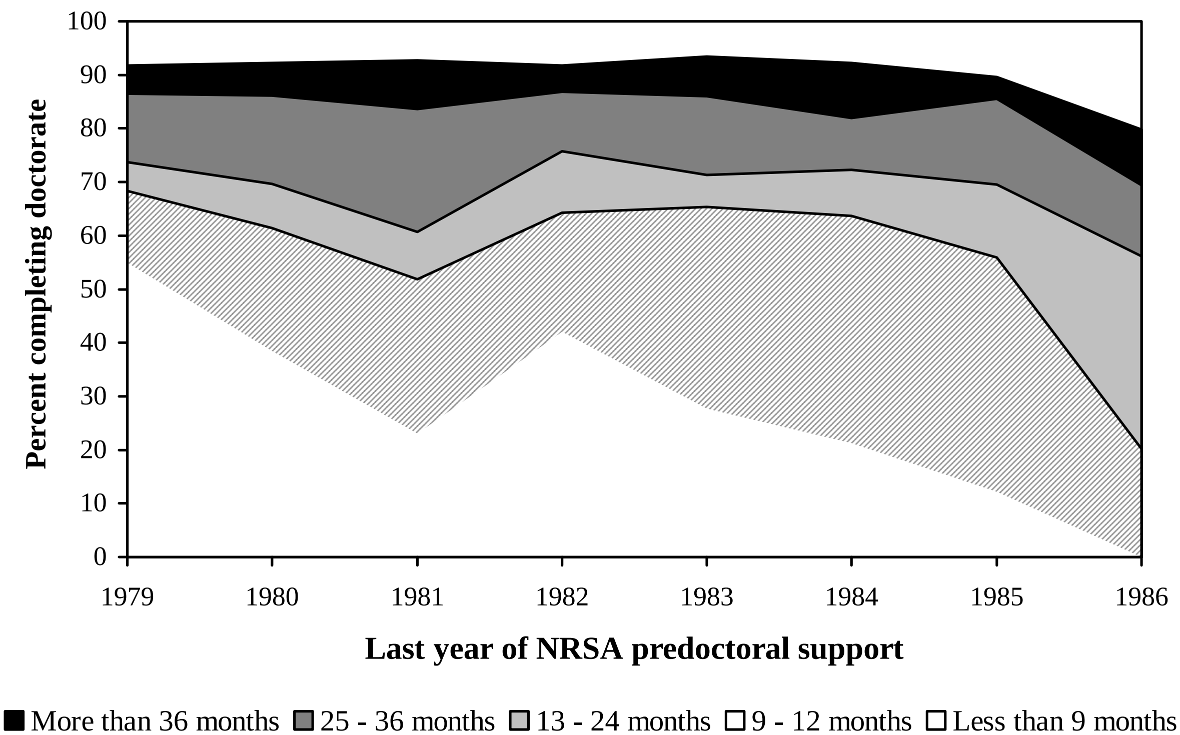
[6]Because data are incomplete regarding year of entry into a doctoral program, the cohorts refer to individuals= last year of NRSA predoctoral support. Research doctorates are defined as those covered by the Survey of Earned Doctorates (e.g., Ph.D., Sc.D., D.N.Sc., and D.Sc.D.). The percentages were derived from simple regressions, using data on previous cohorts and the time required to earn the degree.

[7]Completion rates differed by field; 76 percent of fellows in the life sciences and 71 percent of those in psychology and the social sciences received their doctorates (Baker, 1994). Furthermore, in the social/behavioral sciences, fellows in psychology programs had higher completion rates than their counterparts in the social sciences (79 versus 62 percent). Unfortunately, the data on NRSA predoctoral recipients do not permit comparisons by field.

[8]Although the more recent cohorts had fewer years to complete their doctorate, analyses of previous cohorts indicated that 86.1 percent of trainees and fellows who completed their doctorate did so within five years after their NRSA predoctoral support had ended.

those who were supported for less than one academic year were the least likely to have earned the doctorate by 1992, and the completion rates for those with only 9-12 months were substantially lower than those with two, three, or more than three years of support. Although this pattern is consistent with the argument that length of support and degree completion are related, it should be interpreted cautiously. Receiving NRSA support for only a brief period of time may indeed indicate a student=s (or program=s) decision to not continue in a doctoral program, thus, making him/her unable to receive additional NRSA support.

Figure 1.4
Estimated Percent of 1981-1987 NRSA Predoctoral Trainees and Fellows Who Were Awarded the Doctorate by 1992



Note. For some individuals, months of predoctoral support included other types of NIH predoctoral support (e.g., support provided under earlier training grants that were funded by pre-NRSA mechanisms such as T01 or T05 grants); this is more characteristic for those in the earliest cohorts.

How do these completion rates compare with those of individuals in either the same or different institutions who did not receive NRSA support? Answering this question is difficult due to the scarcity of national-level data (National Research Council, 1996). One previous study estimated that overall retention in graduate biomedical programs *could* be as low as 42 percent (National Research Council, 1989); this would suggest that the completion rates of NRSA trainees and fellows are substantially higher.

Available estimates for specific institutions or samples, however, cast some doubt on the size of this disparity. For the 1978-79 cohort at the University of California at Berkeley, Nerad (1991) found a completion rate of 72 percent for graduate students in the biological sciences; at the University of Pennsylvania, completion rates in the natural sciences ranged from 77 to 94 percent for the 1978-79 entering cohort, depending on field (Miselis, McManus, & Kraus, 1991). At the University of California at San Diego, approximately 82 percent of students entering doctoral programs in the biomedical sciences between 1981 and 1986 completed their Ph.D. within 10 years, and this was true for 71 percent of those in psychology. Sociology and anthropology experienced dramatically lower completion rates B 27 and 44 percent, respectively (http://www-ogsr.ucsd.edu/graddata).[9]

The studies that have examined the relationship between degree completion and type of financial support have yielded mixed findings. For the Medical Research Council fellowship program (Medical Research Council, 1989), the completion rate for fellows in biomedical and behavioral science (74 percent) was not significantly higher than those for students who unsuccessfully applied for a fellowship (65 percent) or who were supported by other sources (86 percent). Bowen and Rudenstine (1992) also concluded that while completion rates for NSF fellows have been generally high, there was no compelling evidence that they exceeded those for other graduate students.[10] At the same time, although not focused on the biomedical and behavioral sciences and restricted to only one institution (Cornell University), Ehrenberg and Mavros (1995) found that fellowships (as well as research assistantships) did significantly increase completion rates and lower drop-out rates *independent of* individual ability.

Thus, given the lack of comparative data and the mixed results of previous studies, it is impossible to determine whether NRSA predoctoral recipients were more likely to complete the degree than other graduate students. One can conclude, however, that completion rates for NRSA trainees and fellows are certainly comparable to those reported for other major fellowship programs and for students in high-quality doctoral programs. If degree completion is more associated with individual merit, the quality of training experiences, and the departmental resources for supporting graduate students, then students in programs at elite institutions will be more likely to complete the Ph.D., regardless of the source of support. At the same time, Ehrenberg and Mavros= (1995) findings suggest that the benefits typically associated with traineeships and fellowships (freedom to spend time on courses and other directly related activities) may positively contribute to earning the doctorate. For those NRSA-supported doctoral programs in institutions with more limited funds for graduate students, NRSA support may play a somewhat stronger role in facilitating completion of the degree.

Major Evaluation Questions and Methodology

The data presented in this report focus on *selected* research career outcomes for NRSA predoctoral trainees and fellows who received doctorates between 1981-92 in the biomedical and behavioral sciences. Of interest are measures of educational attainment, pursuit of further postdoctoral training, employment in

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[9]Neither Nerad=s (1991) nor Miselis et al.=s (1991) studies reported results for the behavioral sciences, but both did find lower percentages for the social sciences (e.g., 49 percent at the University of California at Berkeley).

[10]Contributing possibly to the lack of differences is the fact that the comparison group of Aother graduate students@ were individuals who were enrolled in graduate programs at an elite set of institutions (University of California at Berkeley, University of Chicago, Columbia University, Cornell University, Harvard University, Princeton University, Stanford University, and the University of North Carolina at Chapel Hill). Although larger differences may be found for students at other institutions, it is the case that NRSA support is concentrated in highly ranked institutions.

research-intensive settings, receipt of NIH and NSF research funding, and contributions to the research literature. Other desired outcomes of NRSA predoctoral support, namely, those that may accrue to faculty, training programs, departments, and institutions, are not examined. This is not to say that they are less important; rather, it speaks more to the lack of available data for such assessments.[11] Moreover, it can be argued that one indicator of high-quality training environments is graduates who excel on many of the individual outcomes examined.

Three questions have guided this assessment:

(1) *Have the NRSA programs been successful in achieving their goals?* Examining a program=s performance in terms of meeting its specified goals is a major focus of both legislative and regulatory requirements (e.g., the Government Performance and Results Act). It also is basic to any evaluation effort B if the expected outcomes did not materialize, it then makes little sense to embark on the more complicated process of linking program activities to outcomes. Thus, it is important to document the extent to which NRSA participants pursued successful careers in biomedical and behavioral research, thereby, contributing to the supply of talented investigators in areas of identified need as required by Section 459 of P.L. 93-148.

(2) *How does the performance of NRSA predoctoral recipients compare to individuals who did not receive such predoctoral training support?* Once it has been documented that a program is accomplishing its intended objectives, the focus then shifts to how the achievements of participants compare to those of persons who did not receive NRSA training support. Chapters 3 and 4 describe the results of simple comparisons of NRSA trainees and fellows with their biomedical or behavioral science Ph.D. counterparts who either: (a) were graduate students in the same training environments as NRSA trainees and fellows but were not awarded NRSA support; or (b) were trained in departments that did not have NRSA predoctoral training funds.

(3) *What can be said about the unique role of NRSA predoctoral support over and above other factors that influence progress in a research career?* Typically, the evaluation question of most interest concerns identifying whether the program itself can assume some responsibility for producing the observed outcomes. However, making causal attributions about training programs has always been difficult (e.g., Hansen, 1994; Wagner, 1997), and this task becomes particularly problematic for such merit-based programs as the NRSA (e.g., Carter, Winkler, & Biddle, 1987; Kennedy, 1994; National Research Council, 1989). In the current evaluation, the comparison groups were constructed to partially address one obvious selection bias (i.e., the most talented participants are awarded traineeships and fellowships and further obtain their training in the best doctoral programs), along with other potential differences that could provide rival explanations (scientific field and graduation cohort). Reported in Chapters 3 and 4 are additional analyses that attempted to control for other factors that influence research careers and thus the outcomes of interest.

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[11] Assessing the impact of NRSA training support on departments and institutions has been limited to a handful of studies. For example, the impact of the Minority Access to Research Careers (MARC) program on participating institutions, particularly with regard to scientific curricula, was examined through site visit observations (Garrison & Brown, 1986). Changes in student characteristics, the types and quality of training activities, and departmental resources (e.g., student support) also were examined in a survey to Ph.D.-granting departments with and without training grants (National Research Council, 1978) and in case studies involving two departments that had lost NRSA training support (National Research Council, 1981).

Outcome Measures and Data Sources

For the NRSA programs, the primary goal has been to prepare Awell-trained, highly qualified, and productive research investigators in fields relevant to the advance of biomedical science@ (National Institutes of Health Task Forces for the Review of NIH Biomedical Research Training Programs, 1989, p. 7). To do this, support is given to institutions and individuals to enhance the environment and resources for acquiring research skills. The underlying rationale is that these predoctoral traineeships and fellowships 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 these students with the best possible training opportunities for future career success as independent and productive researchers (National Research Council, 1980). By selecting the best candidates and furnishing them with a period of intense and advanced training, NRSA predoctoral support should help Alaunch them into productive research careers@ (National Research Council, 1994, pp. 90-91).

Functioning as an independent and productive investigator can be assessed in several ways. Three factors were instrumental in selecting the outcome measures and other variables used in this evaluation. First, measures used in previous evaluations were considered important so as to provide some continuity and comparability to earlier efforts (e.g., Baker, 1994; Coggeshall & Brown, 1984; Medical Research Council, 1989; Velletri, Sherman, & Bowden, 1985). Second, research on the factors that best predict early progress toward a research career helped guide the choice of other variables that might help explain differences in outcomes (e.g., Helmreich et al., 1980; Long, Allison, & McGinnis, 1979; McGinnis, Allison, & Long, 1982; Sonnert & Holton, 1995). The final criterion was tied to the evaluation=s reliance on existing data sets and their inclusion of relevant data.[12] The outcome measures are listed in Table 1 and can be summarized as follows:

Educational attainment. The NRSA predoctoral programs are intended to provide opportunities and support for high-quality training that result in attainment of the Ph.D. Completion of this degree also is a necessary prerequisite for other outcomes related to achieving independence as an investigator. Although individuals who leave a graduate program with only a master=s degree can be involved in research, establishing an independent and productive research program as indicated by acquiring external research support and actively publishing is rare.

Another possible outcome of NRSA predoctoral support in general is efficiency of training B i.e., less time to actually earn the degree (National Research Council, 1989). Although the time required to earn the doctoral degree has lengthened in nearly all disciplines, previous studies have shown that federal training support decreased completion time in the biological and health sciences (Tuckman, 1991; Tuckman, Coyle, & Bae, 1990). In addition, speedier completion of doctoral training has been linked with later success as a scientist (Clemente, 1973; Hagstrom, 1971). While some might argue that spending more time in graduate study can enhance career opportunities (e.g., increased time for authoring publications and acquiring additional research skills), it would be troublesome if NRSA recipients consistently took longer to earn their degree than their graduate student counterparts (e.g., higher training costs overall).

[12] The four major data sets are described in Appendix A.

Table 1.1
Summary of Outcome Measures, Populations, and Data Sources

Outcome	Cohorts						Data Source(s)
	81-82	83-84	85-86	87-88	89-90	91-92	
PHD ATTAINMENT							
Completion of the Ph.D.[a]	O	O	O	O	O	O	DRF
Time enrolled in graduate school	O	O	O	O	O	O	DRF
EARLY CAREER RESEARCH-RELATED ACTIVITIES							
Pursuit of (a) postdoctoral training or (b) research-oriented job	O	O	O	O	O	O	DRF
Receipt of NRSA postdoctoral traineeship or fellowship	O	O	O	O	O		TFF
Receipt of non-NRSA postdoctoral training	}	}	}	}	}		SDR
Employed 7-8 years post-Ph.D. in either: (a) academic tenure line positions; (b) academic non-tenure line positions; (c) business and industry; or (d) other settings[b]	}	}	}	}			SDR
Faculty position in major biomedical research institution 7-8 years post-Ph.D.[b]	}	}	}	}			SDR
In a research-oriented employment or training position	}	}	}	}			SDR
APPLICATION & RECEIPT OF RESEARCH SUPPORT							
Applications for NIH/NSF research grants	O	O	O	O	O	O	CGAF, NSF
Overall and early success in obtaining NIH/NSF research grants	O	O	O	O	O	O	CGAF, NSF
RESEARCH PRODUCTIVITY							
Ever published post-Ph.D.[b]	}			}			ISI
Post-Ph.D. publication counts[b]	}			}			ISI
Number of recently authored papers (1990 and 1995)	}	}	}	}	}		SDR
Citation rates for post-Ph.D. articles[b]	}			}			ISI

[a] Data on this outcome were available only for NRSA predoctoral trainees and fellows, and analysis was restricted to those whose last year of NRSA support occurred in FY 1975-87.
[b] Due to problems with insufficient sample size, the employment outcomes pertained only to the job status in 1995 for all cohorts in the behavioral sciences. In addition, the same problem reduced the usefulness of the estimates for publication and citation counts, and thus, these were not reported for the behavioral sciences.

■ Data were collected for all individuals in the three groups.

} Data were collected for a probability sample of the groups.

- *Postdoctoral training.* For several biomedical disciplines, postdoctoral research training is expected, although this is less true in such fields as psychology, nursing, and public health. Even in these areas, however, the choice to pursue postdoctoral training can be conducive to later research success. This may be particularly true for NRSA postdoctoral trainees and fellows, given that training is specifically focused on relevant fields of health-related research and receipt of these awards is traditionally considered an honor. Traineeships and fellowships also may provide more actual *training* than may be available under some postdoctoral support mechanisms (e.g., serving as a postdoctoral research associate on a faculty grant). Thus, levels of participation in NRSA or other postdoctoral training were summarized.

- *Employment in research-intensive environments.* In order to be successful as an independent investigator or in other research roles, one must be in an environment that supports and rewards research. Thus, variables associated with early employment were compared among the three groups, including the type of position taken 7-8 years after the doctorate and the research intensiveness of the institution for those with academic appointments.

- *Application for and success in receiving an NIH or NSF research grant.* Applying for and being awarded external research support, particularly an NIH research grant, are desired outcomes of NRSA predoctoral research training programs. The reasons are obvious C conducting research and publishing its results require resources. Although data were not available for all sources of research support (e.g., private foundations and industry), the Department of Health and Human Services (of which the NIH is the largest component) ranked first in terms of federal obligations for academic research and development in the life sciences and psychology; the NSF was the lead funding agency in the social and environmental sciences (National Science Board, 2000).

- *Post-Ph.D. publications and citations*. Publishing one=s research and the extent to which other investigators refer to this work are widely-accepted measures of research activity and research quality. In fact, when asked to evaluate the quality of a group of biological scientists, distinguished biologists most heavily relied on the individuals= annual publication rate in contrast to such other attributes as current rank and prestige of the employer (Sonnert, 1995). For two cohorts (1981-82 and 1987-88), counts of the number of articles published between 1981-95 and appearing in journals indexed by the Institute for Scientific Information (ISI) were obtained, along with the number of citations these articles received during this time period.[13]

The Target Population

Assessment of early career outcomes was limited to Ph.D. s in the biomedical and behavioral sciences who earned their doctorates between 1981-92.[14] This was done for several reasons. Most important, the

[13]Many previous evaluations have relied on the National Library of Medicine=s database MEDLARS to collect data on publication counts. Because the current study not only included the biomedical sciences but also the behavioral sciences, a small-scale study was conducted, comparing the article counts produced by MEDLARS versus the ISI databases for these two major field groupings. Although the difference between the two sources for the biomedical sciences was negligible, the coverage by the ISI was more complete for the behavioral sciences and, in some fields, provided better measurement of research contributions (e.g., methodological papers).

[14]Identification of Ph.D. recipients was based on the Doctorate Records File (DRF). Given that NRSA recipients must be U.S. citizens or permanent residents, selection was restricted to those whose citizenship was known. Because citizenship data were missing for only a small minority of individuals (between 2-3 percent, depending on the

marketplace encountered by these cohorts was significantly different from that experienced by those who earned their Ph.D.s in the 1970s. For example, industrial employment more than doubled during the 1980s. While the number employed in academic positions remained relatively stable, increasing Ph.D. production meant more new scientists seeking such positions. This may have facilitated, at least in part, the increasing use of positions outside the traditional faculty ranks, e.g., research and teaching associates, by colleges and universities (Garrison & Gerbi, 1998; Lehming, 1998; National Science Board, 2000). Competition for new grants intensified, with success rates at the NIH falling from 33.1 to 25.4 percent between 1985 and 1994. Such trends have prompted increasing concern over the possibility of oversupply in the life sciences (e.g., Marincola & Solomon, 1998; Massy & Goldman, 1995; National Research Council, 1998).

The NRSA training initiatives also were phased in over time. This means that during the late 1970s, the majority of NIH-supported trainees and fellows were funded by previous training mechanisms. For example, of the 1975-80 Ph.D.s who received any NIH predoctoral training support, 79 percent of those in the biomedical sciences had been funded under pre-NRSA training mechanisms, along with 93 percent in the behavioral sciences. Data are scarce concerning the extent to which the training funded under these earlier mechanisms was actually different from that provided by the NRSA, but observations by NIH staff suggest some distinctions.[15] As such, focusing on those individuals whose majority of support came from NRSA-funded programs helps curtail any problems associated with interpreting observed differences that could be a product of pre-NRSA training.

Finally, restricting the population to those who earned a Ph.D. no later than 1992 allowed a sufficient time for several outcomes to occur. The high incidence of postdoctoral training in the biomedical sciences and the increasing time being spent in postdoctoral study implies that certain career Amilestones@ are not likely to occur earlier than 6-7 years after the doctorate. Thus, examination of such outcomes as receiving an NIH or NSF research grant was not performed for the most recent cohorts (1989-92).

The Study and Comparison Groups

NRSA predoctoral support is restricted to those who are U.S. citizens or permanent residents. Consequently, the study and comparison groups did not include Ph.D.s who were non-U.S. citizens on temporary visas at the time they earned their doctorate. Also excluded were those who earned their degree from a foreign institution.

The NRSA study group. Assignment to the NRSA study group was restricted to those who had received nine or more months of NIH traineeship (T32) or fellowship (F30 or F31) support. This involved 12,441 Ph.D.s in the biomedical sciences and another 2,440 in the behavioral sciences, the majority of whom received their support through an institutional training grant. The criterion of nine months was chosen, based on the assumption that being supported for at least one *academic* year was necessary in order to consider that any observed difference in outcomes could be associated with NRSA support.[16] Those individuals who

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survey year), imposing this criterion was not judged as a potential serious source of bias.

[15]For example, individuals funded under the T01 mechanisms (the precursor to the T32 traineeship) by the NIGMS may have received no different training than their T32 counterparts. At the same time, T01s were used by some Institutes to support clinical training, particularly the former ADAMHA Institutes. Without a case-by-case examination of individual training grants, such distinctions could not be easily identified.

[16]A small number of training grant awards are somewhat different than the typical training grant. That is, the award is administered by a non-degree-granting organization (typically a scientific or professional society), which then

received less than nine months of NRSA support (177 biomedical and 62 behavioral science Ph.D.s) were assigned to the first comparison group.

The two comparison groups. In order to guard against group differences in outcomes stemming from field differences, both comparison groups were composed of individuals who earned their doctorates in the same disciplines as NRSA trainees. Although the ideal situation would have been to use individuals who entered doctoral programs at the same time as former trainees and fellows, this strategy was not possible due to the lack of sound data on the specific doctoral program and the date of first enrollment. The alternative involved constructing an interval of ±5 years from the Ph.D. year of each NRSA predoctoral recipient, and comparison group members were then those who earned their degrees in the same field during this time period. Because individuals varied in the amount of time required to complete the doctorate, this strategy was believed to more completely capture individuals who had been graduate students during the same period as former NRSA recipients.

The key difference in the composition of the two comparison groups involved their predoctoral Atraining environment@:

Individuals from departments with NRSA predoctoral training grants. This group consisted of Ph.D.s who were graduate students in the same departments as the NRSA trainees but who received less than nine months of NRSA training support. Included here were 15,992 individuals with biomedical Ph.D.s and 6,684 individuals with doctorates in the behavioral sciences. This group was viewed as the most similar to the NRSA recipients in terms of both individual-level and training characteristics B they should have been admitted under the same criteria (e.g., GRE scores and undergraduate GPA) as the NRSA-supported Ph.D.s., and they most likely were exposed to those courses, training practices (e.g., sequencing of courses and degree requirements such as earning a master=s degree), faculty, and resources that were not dependent on NRSA support. It also is plausible that they were socialized by and interacted with their NRSA-supported counterparts and benefitted from certain NRSA-sponsored training components (special courses and colloquia) that had been developed with training grant funds.

Individuals from departments without NRSA predoctoral training support. Members of this comparison group were those Ph.D.s who had been graduate students in programs and departments that had not had NRSA predoctoral training grants during this time period. This group included 15,037 individuals in the biomedical sciences and 14,388 Ph.D.s in the behavioral sciences. As such, the characteristics and training experiences of these individuals were expected to be more different from those of both NRSA predoctoral recipients and their fellow graduate students who graduated from the same departments but were not awarded traineeships or fellowships.

Because data on the department that awarded an individual=s Ph.D. are not available and degree field may not always match that of the specific department, the two comparison groups will be referred to as Ph.D.s from NIH training institutions and Ph.D.s from non-NIH training institutions.

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solicits applications from individual students and makes awards on the basis of peer review. Because of this selection process and the fact that students are spread across several different institutions, these awards were viewed as more similar to fellowships than traineeships; thus, they were recoded accordingly.

The special problem in the behavioral sciences. The NRSA programs supported individuals in nearly all areas of psychology, sociology, anthropology, and the speech and hearing sciences. Although these individuals were included in the analyses of NRSA training characteristics (Chapters 1 and 2), only certain fields were retained for the outcome comparisons. This is partly a function of the different career paths and options open to and taken by doctorates in the different disciplines.

The most visible example is psychology, which includes subfields that involve training in both research and mental health services delivery and others that focus entirely on producing basic and applied researchers. For several years, the majority of all psychologists and new doctorate recipients have been trained in clinical, counseling, and school psychology. Although many of these graduated from Ph.D. programs that provided both research and clinical training, an increasing number earned their degrees from professional schools of psychology that focused primarily on training practitioners B 15 percent of new clinical, counseling, and school psychology doctorates in 1987 versus 30 percent of those in 1993. These programs are very different in terms of the emphasis on and resources for research training. For example, they have higher student/faculty ratios, they use more part-time instructors, and their faculties are less likely to publish (Maher, 1999).

In addition, most clinical, counseling, and school psychologists end up pursuing careers as full-time practitioners. Because the increase in psychology doctoral production during the 1980s was mainly due to degrees awarded in these subfields and because doctoral programs in these fields rarely had NRSA predoctoral training grants, their graduates overwhelmed both comparison group populations. For example, whereas clinical, counseling, and psychology comprised the degree fields of 11 percent of trainees and fellows, they accounted for 37 and 51 percent of the two comparison groups, and a healthy portion of comparison group members in these fields graduated from professional schools of psychology (12 percent).

These disparities introduced the distinct possibility that any observed differences in research careers between the NRSA study group and comparison groups could be primarily due to the different career paths and opportunities available for those who were or were not trained for health services provision. A similar situation occurred with regard to the speech and hearing sciences. Due to the relatively small numbers of NRSA predoctoral recipients in these fields, separate examination of their outcomes was not appropriate. Consequently, excluded from all outcome analyses were former trainees and fellows, along with those in the comparison groups, who received their degrees in speech, audiology, and clinical, counseling, and school psychology.[17]

Structure of the Analyses and Organization of the Results

Given that the path toward becoming a researcher differs by field, the following sections report outcomes separately for the biomedical and behavioral sciences. Depending on the outcome of interest, results are presented for four to six of the following Ph.D. cohorts B FY 1981-82, 1983-84, 1985-86, 1987-88, 1989-90, and 1991-92. Two-year cohorts were used so as to improve comparison across different outcomes by having ones that were compatible with those in the Survey of Doctorate Recipients (SDR), the chief source of data on doctoral employment. Also, the use of two-year cohorts helped to reduce instability and chance fluctuation in estimates of outcomes that rely on sample survey data.

[17]For 1981-92 Ph.D.s who received nine or more months of NRSA predoctoral support, approximately 1 percent were in the speech and hearing sciences. Those in clinical, counseling, and school psychology accounted for a larger proportion (11 percent overall), but the numbers in each two-year cohort still were relatively small, ranging from 24 of 1981-82 Ph.D.s in the NRSA study group to 75 of the 1991-92 cohort. This precluded examining them separately.

Rather than conducting omnibus statistical tests that compare outcomes *across* the three groups, group differences were examined in a pair-wise fashion; for example, the application rate of former NRSA trainees and fellows was contrasted with that of Ph.D.s who graduated from the same departments. This strategy was adopted, given that the Aselection processes@ were expected to differ between the two comparison groups. As previously mentioned, training grants are awarded on the basis of peer review and are intended for programs judged to be of high quality in training researchers. The Ph.D.s from these departments B both those with and without NRSA predoctoral support B all applied to, were accepted into, and graduated from these programs and should be more similar in terms of *individual talent*. They also would encounter the same faculty and have available certain training resources (e.g., other monies available to support graduate students and associated training costs). The extent to which those receiving NRSA predoctoral training support have unique characteristics and training experiences is unclear.[18] Thus, group differences in successfully pursuing a research career may well be smaller, particularly given the role of doctoral program quality and reputation in predicting certain accomplishments (e.g., obtaining a faculty position and publication records). In contrast, the departments without NRSA predoctoral training grants tend to have less visible doctoral programs, and their graduates should be more similar to each other in terms of relevant attributes and training experiences than they should be to former trainees and fellows.

In deciding what constitutes a Adifference,@ two criteria were used. The first criterion, of course, was statistical significance. However, given the large sample sizes in the groups for some outcomes, the effect size also served as a guide. This index is used to express, using standard deviation units, the difference between two groups on a particular measure (Cohen, 1988). Sample sizes are not taken into account in these calculations. Using this statistic is beneficial in identifying meaningful group differences. For example, while a 2 percentage-point difference may be statistically significant (due to the large sample sizes and the small errors of estimate), it may produce a negligible effect size. Criteria exist for what constitutes a potentially small, medium, and large effect (see Cohen, 1988):[19] (a) an effect size of 0.20 is considered to be indicative of a Asmall@ effect; (b) an effect of 0.50 is viewed as Amedium@; and (c) effect sizes that are at least 0.80 are considered to signal a Alarge effect.@ Given that most educational programs have produced small effects (e.g., problem-based learning in medical education), this also may be true for the NRSA programs, particularly inasmuch as many outcomes occur well after the conclusion of NRSA training. Thus, it was decided that a group difference that was statistically significant and was of the magnitude of 0.20 or higher would be worthy of noting and probing further to examine its robustness (Lipsey, 1990; Lipsey & Wilson, 1993).[20]

Examination of group differences. Of course, the extent to which these statistics signal an actual "effect" depends on several factors. Differences in outcomes for NRSA fellows and trainees can result from one or more of the following: (1) the groups are non-equivalent at the beginning of training on variables that

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[18] Anecodotal information suggests that selection practices may not be the same across programs, with some claiming that those chosen to receive traineeships are the most talented graduate students and others indicating that several variables contribute to the assignment of financial support to a student, including his/her success in obtaining other competitive university fellowships, undergraduate teaching demands, etc.

[19] Cohen (1988) arrived at these conventions after examining the distribution of effect sizes across a wide range of research. An empirical examination of 186 meta-analyses of observed effects for programs in a diverse group of areas, including postsecondary education, found that a third of the positive effect sizes were between 0.0 and 0.32 (which was designated as Asmall@), another third lay between 0.33 and 0.55 (Amoderate@), and the final 33% were between 0.56 and 1.20 (Lipsey, 1990).

[20] Significance levels and effect sizes are not reported in the text, but are included in the appendix tables.

contribute to career achievements; (2) the outcome measures were subject to errors in measurement or were pale reflections of career progress (e.g., problems with reliability, validity, and sensitivity); and (3) differences were distorted due to problems with non-response or otherwise incomplete data. Although the plausibility of these other competing explanations cannot be fully examined, two attempts were made to incorporate the role of pre-existing differences on relevant characteristics captured in the extant data sets. First, given that career paths and opportunities differ across disciplines, outcome comparisons by broad disciplinary groups were performed wherever sample sizes permitted them. In a few instances, outcomes were also compared for other types of subgroups (e.g., those with and without postdoctoral training).

Second, for those simple (i.e., unadjusted) comparisons where differences satisfied the two criteria of statistical significance and effect size, multivariate analyses were performed, controlling for several variables related to individual characteristics, training experiences, and other career factors. This involved the use of multiple regression where outcomes were continuous variables and logistic regression for those measured in a dichotomous fashion (Long, 1997). The choice of variables for individual characteristics and other factors was governed by the findings of previous research and the analyses of group differences on these variables.

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