Chapter 3
Early Career Outcomes of NRSA Predoctoral Training in the Biomedical Sciences

This chapter chronicles the early careers of NRSA predoctoral recipients in the biomedical sciences, contrasting them with those of their Ph.D. counterparts who did not receive such support. The outcomes examined range from the time required to earn the doctorate to the number of publications authored and citations received by 1995. Of interest are those Ph.D.s who earned their degrees between FY 1981 and 1992. The rationale is twofold. First, members of the NRSA study group who received their degrees prior to 1981 were likely to have had their NIH training support from pre-NRSA training programs, which may or may not have been similar to those funded after enactment of the NRSA legislation. Second, given the prevalence of postdoctoral study and the availability of data through 1995, this allowed sufficient time for most cohorts to have made some initial progress toward establishing a research career in their chosen field.

In assessing career progress, attention is first directed at describing the extent to which former NRSA predoctoral trainees and fellows were successful. Their accomplishments are then compared with those of their fellow doctorates who did not receive NRSA predoctoral training support B both those who graduated from departments with and without NRSA predoctoral training awards. Although the completion of a Ph.D. should have predisposed all groups to work toward establishing a research career, the characteristics associated with NRSA training support may have facilitated this process in certain ways. For example, biomedical Ph.D.s who held NRSA predoctoral traineeships and fellowships were more likely to have been trained at an elite group of institutions with high-quality doctoral programs B ones that had successfully competed for training grants. Based on what is know about scientific careers, this may have improved graduates= ability to secure faculty appointments, particularly at prestigious institutions. Of course, this competitive advantage may not be distinctly different from that of their graduate student counterparts from the same department (and with the same academic pedigree). It may, however, be greater than that of biomedical scientists who graduated from departments without NIH training grants.

As a brief review, outcomes included: (1) time to complete the doctorate; (2) postgraduation commitments for research-related training or employment, along with specific receipt of an NRSA postdoctoral traineeship or fellowship; (3) research-related employment 7-8 years after Ph.D. completion; (4) application for and receipt of at least one NIH or NSF research grant prior to FY 1995; and (5) number of post-Ph.D. publications and citations to those articles by 1995.

Time Required to Complete the Doctorate

As noted by the National Research Council (1989), completing the doctorate in less time can be one attribute of efficient and effective training programs, all else being equal. Although longer training periods are not necessarily worse (e.g., more content can be addressed, material covered in greater depth, and research experience acquired), concern has been expressed over the lengthening time-to-degree (e.g., Association of American Universities, 1998; Committee on Science, Engineering, and Public Policy, 1995). The reasons are several. First, lengthier degree times may, in the long run, dissuade talented individuals from entering doctoral programs, particularly in fields where additional postdoctoral training is viewed as desirable. Second, they can contribute to higher attrition among graduate students as well as postpone entry into the labor market (Ehrenberg, 1992). Third, longer completion times may be symptomatic of such problems as stagnant job markets, insufficient financial support, and onerous demands placed on teaching and research assistants.

A more explicit rationale for considering time-to-degree as an outcome is that the provision of stipend and tuition assistance should allow NRSA trainees and fellows to pursue their studies full-time. Thus, they should be less vulnerable to disruptions and other demands that interfere with and prolong graduate study. This may be particularly important, given that how graduate study is financed can influence completion times. Although the evidence is mixed, teaching assistantships and outside employment have been found to extend time in graduate school whereas fellowships, in particular, may shorten it (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; National Science Board, 2000; Tuckman, Coyle, & Bae, 1990). Moreover, the time required to become an independent investigator in the biomedical sciences typically involves additional years of postdoctoral training. As such, it would prove somewhat unsettling if this time was extended by more years spent in graduate school for those supported by NRSA predoctoral training funds.[1]

Although time-to-degree has been measured in several ways, differences in registered time-to-degree (RTD) were of most interest in these analyses. This measure attempts to capture only the time that a student spends *formally* working toward a degree and excludes periods when (s)he is not formally enrolled in graduate study.[2] In determining how various forms of financial aid and institutional variables affect the length of graduate study, these exclusions also make its use more appropriate (Tuckman, 1991).

It is the case that completion time in all fields lengthened during the time period examined (Henderson, Clarke, & Woods, 1998). In the biomedical sciences, there was an 8-month increase in the average RTD, which rose from 6.4 years for the 1981-82 cohort to 7.1 years for 1991-92 Ph.D.s.[3] However, the time required to earn the doctorate and the extent to which it increased for later cohorts differed among disciplines. In the basic biomedical sciences (e.g., biochemistry, cell and molecular biology, neuroscience, and genetics), time-to-degree was typically shorter overall, and it increased less. For 1981-82 Ph.D.s, the average RTD was 6.2 years; this rose by 11 percent to 6.9 years for 1991-92 doctorates. In contrast, earning a degree in the health sciences took an average 6.6 years for those graduating in 1981-82 but 7.8 years for Ph.D.s graduating a decade later C an increase of 17 percent.

NRSA predoctoral trainees and fellows generally completed their degrees in less time than the two comparison groups. Across all cohorts, the average was 6.5 years for the NRSA study group as compared to 6.9 for the NIH training institution group (a 4-month difference) and 7.0 for the non-NIH training institution group (a 5-month disparity). As shown in Figure 3.1, earlier cohorts in all groups spent less time enrolled in graduate study than did later cohorts. For example, looking at 1981-82 doctorates, the mean RTD was 6.0 years for NRSA trainees and fellows as compared to 6.5 for both comparison groups. For 1991-92 graduates, the NRSA study

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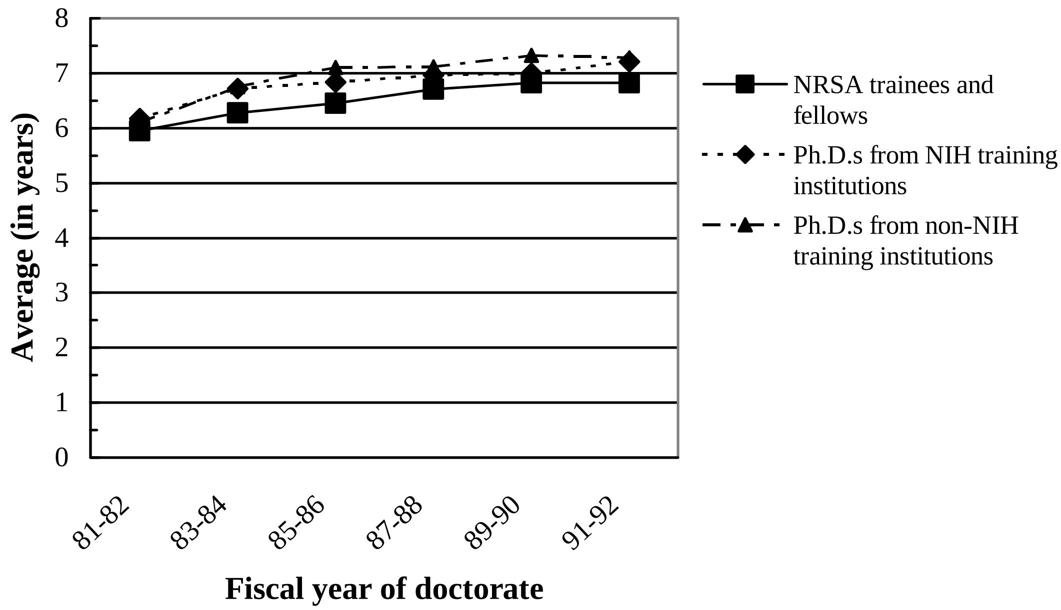
[1]Longer time-to-degree for NRSA trainees and fellows could signal potential problems in the selection criteria used to appoint individual trainees and the timing, length, and continuity of NRSA support.

[2]Although this measure neither differentiates between full- and part-time enrollment nor excludes time spent enrolled but involved in unrelated activities (e.g., part-time jobs), it does *exclude* time spent away from graduate study such as when an individual earns a master=s degree, works for awhile, and then enters a doctoral program, sometimes in an entirely different field and/or institution. Because taking time out between the master=s and doctoral degree was more characteristic of comparison group members, this argues for using RTD rather than such alternatives as the time elapsed between baccalaureate and Ph.D. receipt (total time-to-degree or TTD) or years elapsed between first entry into any graduate program and awarding of the doctorate (elapsed time-to-degree or ETD).

[3]To reduce the effects of outliers, all analyses excluded cases that were ± 3 standard deviations from the mean.

Figure 3.1
Average Time Enrolled in Graduate Study for 1981-92 Biomedical Ph.D. s by Group and Major Field

All Fields



Fields with Shorter RTD

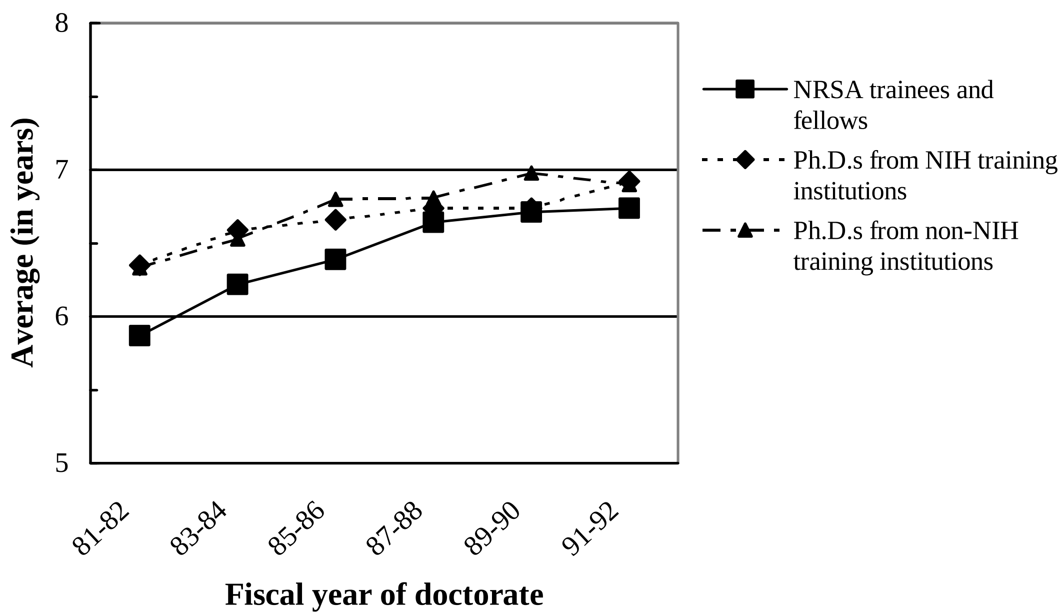
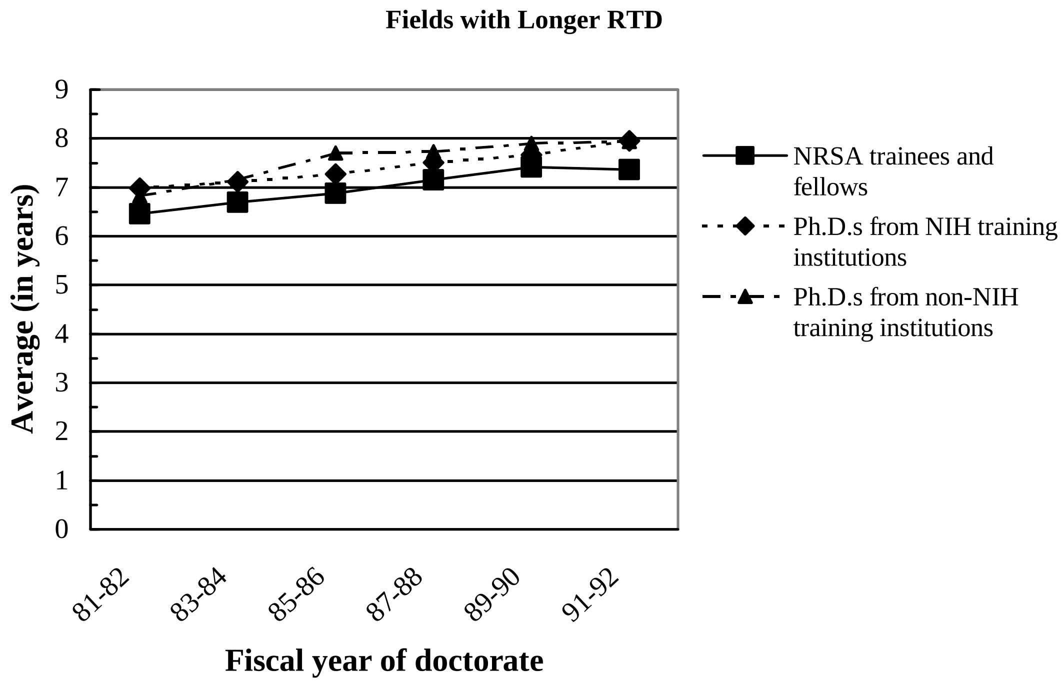


Figure 3.1 (*continued*)
Average Time Enrolled in Graduate Study for 1981-92 Biomedical Ph.D. s by Group and Major Field



Note. Data are from Appendix Tables D.1a B D.1c.

grroup completed their degrees, on average, in 6.8 years; the means for their fellow graduate students and those from other institutions were 7.2 and 7.3 years, respectively. This lengthening of degree time for all Ph.D.s but shorter time-to-degree for NRSA trainees and fellows are consistent with previous evaluations of NIH training programs (Coggeshall & Brown, 1984; National Research Council, 1976)

Given that disciplines differ in time-to-degree and the study and comparison groups did not have the same disciplinary make-up, it is useful to compare completion times for different fields. Two major clusters were identified, based on their completion times for 1981-92 doctorates. These clusters were intended to reflect differences in requirements associated with doctoral programs, nature of research projects, availability of financial support, and other factors which has been shown to relate to the varying completion times among fields (Nerad, 1991). In the first cluster were those fields where the median RTD was below 7.0 years, which included nearly all disciplines in the basic biomedical sciences (see Appendix Table D.1b for a listing of the fields). Here, doctoral programs are often located in medical schools, graduate students are involved in actual research soon after entering the program, the earning of a master=s degrees may or may not be required, and research is conducted in campus laboratories by teams of graduate students, postdocs, and senior scientists.

In contrast, the second cluster consisted of fields where the median RTD was at least seven years. These were likely to be doctoral programs in the other biological and health sciences such as zoology, nursing, and public health (Appendix Table D.1c identifies the specific fields). Programs in this group were more frequently found in colleges of arts and sciences and other health profession schools, research often involves data collection outside the laboratory, research teams are less common, and the master=s degree is a typical step on the way to the doctorate.

As the bottom two graphs in Figure 3.1 indicate, the shorter time-to-degree for the study group as contrasted to those without NRSA predoctoral support was most noticeable in the earlier cohorts (1981-86) but was no longer evident for later cohorts in the cluster with traditionally shorter completion times. However, consistently small and significant group differences characterized the fields where earning a doctorate usually required seven or more years. Here, former NRSA trainees and fellows graduated in less time, particularly when compared to their counterparts from non-NIH training institutions.

The Role of NRSA Predoctoral Support and Other Factors on Time-to-Degree

To more closely examine the contribution of NRSA to shorter degree completion, multiple regressions were performed, taking into consideration other factors that may contribute to the observed group differences in completion time. These variables included those that previous studies had found to predict time-to-degree, along with ones that represented pre-existing differences between study and comparison groups members (see Chapter 2). For example, being older at the time of entering a graduate program, female, or an ethnic minority has been associated with lengthier completion times (Coyle & Thurgood, 1989; Seagram, Gould, & Pyke, 1998; Tuckman, Coyle, & Bae, 1990; Wilson, 1965). Time-to-degree also has been longer for individuals who graduate from less distinguished doctoral programs (Bowen & Rudenstine, 1992; Goldberger, Maher, & Flattau, 1995). As previously reported, there were differences between the NRSA and comparison groups on many of these characteristics. Relative to comparison group members, former trainees and fellows began graduate study at a younger age, they included a smaller percentage of individuals from underrepresented minority groups, and they were less likely to have completed their master=s and doctoral training at different institutions. The models also included the year of the Ph.D. to capture time trends and other variables to reflect labor market conditions.[4]

The results of the regression analysis suggest that completion times were affected by several factors. In addition to later cohorts requiring more time to complete the degree, earning a master=s degree also increased the time spent in graduate school. This was particularly true when master=s and doctoral training occurred at different institutions. Controlling for all other variables, this added approximately 16 months to the time spent enrolled in graduate study. Although the reasons are not explicit, this probably reflects the need to take additional courses to satisfy degree requirements at the doctoral institution (e.g., credit hours at the new doctoral institution). For those with both graduate degrees from the same university, it may reflect the added time needed to complete a master=s thesis or other requirements for that degree. Having to finance one=s graduate study from an outside job also noticeably affected degree time as compared to other sources of support. The role of other variables on which the NRSA study and comparison groups differed (e.g., age at entering graduate school and earning a degree from a distinguished institution), for the most part, extended the time-to-degree by only very small amounts.

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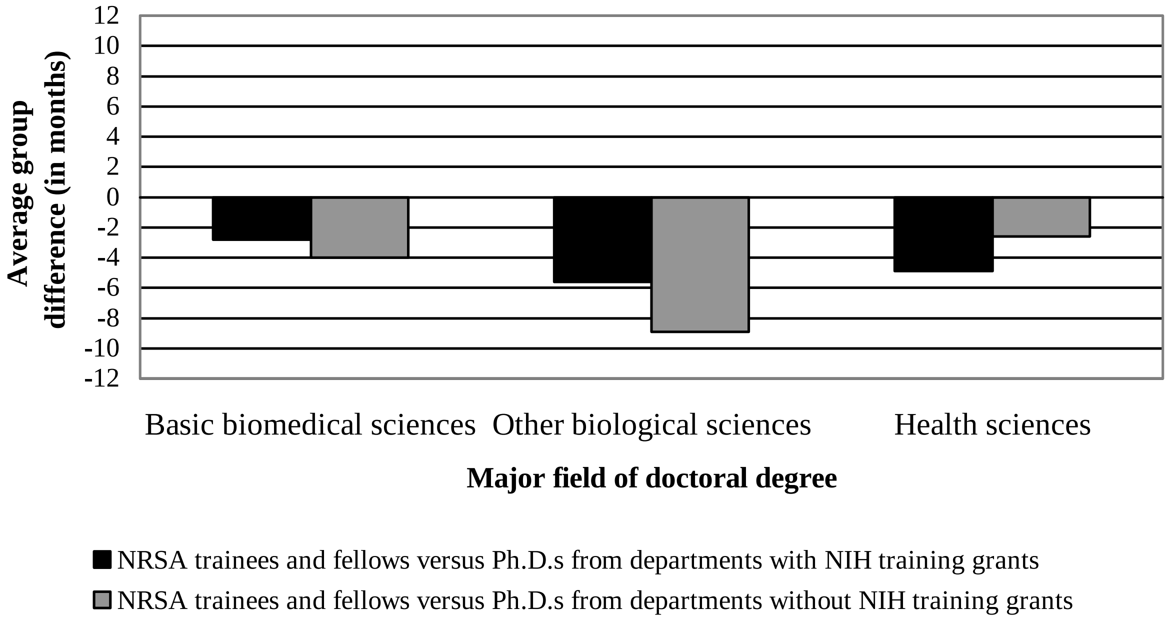
[4]Similar to the Tuckman, Coyle, and Bae (1990) study, the index of labor market conditions was defined as the percentage of doctorates who did not have firm postdoctoral study or employment commitments at the time of graduation in a specific Ph.D. year and field. Because disciplines also differ in the extent to which further postdoctoral study is expected, the percentage of individuals having definite employment commitments or seeking employment, again by Ph.D. year and field, was included in the analysis.

The contribution of having an NRSA predoctoral traineeship or fellowship was reduced once receipt of a master=s, along with other variables, were taken into account, but it did not disappear. As Figure 3.2 suggests, it appears to have slightly more impact for individuals in programs outside the basic biomedical sciences. Whereas it makes very little difference for trainees and fellows in such fields as biochemistry and neuroscience compared to students from the same or different programs, it does speed up degree completion to a greater extent for those earning degrees in other biological sciences (e.g., biology and zoology).

Figure 3.2
Average Adjusted Difference in RTD by Broad Field of Doctorate and Group: 1981-92 Biomedical Ph.D.s



Note. Data are based on the regression model described in Appendix Table D.2. The differences pertain to the time formally enrolled in graduate school for NRSA trainees and fellows relative to a respective comparison group. Because time is measured in years, a negative difference in favor of the NRSA study group means less time spent earning the degree.

Explaining Differences in Time-to-Degree Among NRSA Predoctoral Trainees

Despite the fact that time spent in graduate school was not strongly related to receipt of NRSA predoctoral support, shorter completion times do possess some advantages not only for the student and also for the doctoral institution and the NIH. One is economic, given that tuition, living expenses, and other training-related costs have risen markedly. For example, Geiger (1997) estimated that the cost of graduate support at a top private university grew from $2,700-3,200 per year in 1960 to $29,000-$36,000 per year in 1994. These costs may be higher for those who spend longer times earning a doctoral degree, which can then put departments in the position of having to find additional support. Furthermore, the costs of doctoral study have risen at a faster pace than the NRSA training budget, causing Institutes to place limitations on the amount reimbursed for tuition and to have fewer funds available for new training grants and initiatives. It also is the case that longer time-to-degree extends the total time associated with beginning efforts to establish a career as an independent investigator.

Certain features of NRSA-supported training may affect the amount of time spent in graduate school, and identifying these could help in the future planning of training grant policies and programs. Although shorter completion times is not a primary objective of the NRSA programs, it has some relevance, given the recent recommendation that the doctoral degree should be earned within six years, particularly in fields where additional postdoctoral training is required, and that training grants should serve as models for graduate programs (Federation of American Societies for Experimental Biology, 1997; Committee on Science, Engineering, and Public Policy, 1995).

Thus, for the population of Ph.D.s who had received NRSA traineeships, multiple regressions were again performed, including as predictors the variables previously listed as well as a limited set of indicators that could be derived from the training grant data maintained by the NIH. This latter set of variables was intended to describe aspects associated with NRSA support. In addition to months of NRSA predoctoral support, of interest were: (a) receipt of both a traineeship and fellowship, which may signify individual commitment to and success in progressing through a doctoral program; (b) receipt of MSTP support, one indicator of a specific type of training experience and program requirements which may affect degree progress; (c) the Amaturity@ of the training grant as reflected by the number of years that it had been in operation and the number of doctorates who had been produced by the time the individual had completed the degree; (d) the timing of NRSA predoctoral support, which if provided during the first three years of doctoral study could be an indicator of recognized talent (i.e., training directors select the best incoming students) and also signify the opportunity to focus entirely on graduate classes and requirements without being disrupted by teaching assistantship or other responsibilities; and (f) the location of training (medical school versus college of arts and sciences versus other administrative entity), a variable that may suggest something about the context and available sources of graduate student support (e.g., teaching assistantships are less commonly used by programs in medical schools).

In a separate regression, this set of NRSA support characteristics by themselves accounted for approximately 10 percent of the variation in time-to-degree among trainees. However, the contribution of NRSA and non-NRSA variables as a whole was 31 percent. Again, later cohorts required more time to earn the degree. Entering a doctoral program with a master=s from a different institution also increased degree time substantially by 1.8 years, and earning the master=s degree, all else aside, was responsible for adding about 5 months. Such other variables as gender, age upon entering graduate school, selectivity of the undergraduate institution, and prestige of the doctorate-granting institution either were not significant predictors or helped explain only a small amount of variation in time-to-degree.

However, the influence of the non-NRSA variables did not erode the contribution of the NRSA variables; they accounted for 13 percent of the variance after taking the other variables into consideration. Among this group, the most notable factors were length and timing of NRSA support (see Appendix Table D.3). While providing support to students for longer periods of time did slightly lengthen time-to-degree (those with 1-3 years of NRSA support graduated in an average 6.3 years compared to 6.6 years for those who were supported for longer periods of time), awarding it to them within the first three years of graduate study versus later *decreased* time-to-degree by an estimated 10 months. That is, controlling for all other variables, the means for trainees whose support occurred early on were 6.3 years versus 7.1 years for those receiving their first support after that. Given that these two variables are not entirely independent, their interaction indicates how they operate in conjunction. When provided early, longer periods of support increased time-to-degree much less than when provided late. Among trainees and fellows who received their support early in the course of their graduate study, the adjusted means for those with three or fewer years of NRSA predoctoral support versus more were 6.1 years vs. 6.4 years. However, for those who were appointed to training grants much later, the average adjusted completion time was 6.9 years for individuals receiving 1-3 years of support, and receipt of additional support increased this to 7.9 years.

In general, this suggests that targeting traineeships for those engaged in the early stages of their doctoral study, all other things considered, can facilitate progress through graduate school and movement onto the next step toward becoming an independent investigator. As such, it provides a partial rationale for encouraging training programs to allocate support to beginning graduate students and those in the early years of training and endorses the overall philosophy of the training grant mechanism, which is designed to support these early years of study through tuition assistance and stipends.

Summary

Taken together, the above patterns indicate that the receipt of NRSA support plays a very small role in making graduate study more Aefficient.@ This is not necessarily inconsistent with previous research, which suggests that the effect of various forms of financial support is more pronounced for reducing drop-out rates than for completion times (e.g., Ehrenberg & Mavros, 1995). Also, the quality of the data on sources of support, which do not capture such characteristics as length and sequence, may have hampered the ability to discern a stronger relationship.

Although some believe that shortening degree time is an unrealistic expectation, several groups have endorsed the concept that earning a Ph.D. should require no more than 5-6 years C a figure that was much closer to the average length of time for doctorates in the earlier cohorts. Shorter degree times may assume added importance in fields like the biomedical sciences where additional years in postdoctoral training are expected. The establishment of a new doctoral program at the Cold Springs Harbor Laboratory that is intended to be completed in 4.5 to 5 years reaffirms the possibility that doctoral training may be streamlined (Mervis, 1998). Graduate schools, in general, have become more sensitive to the need for facilitating degree progress and are now considering ways to optimize requirements, and circumscribe the scope of the Ph.D. thesis (Association of American Universities, 1998).

Whether changes in practices related to NRSA predoctoral support can contribute to this process is unclear, but the analyses of time-to-degree for NRSA trainees indicate that those provided with traineeships in the very early years of graduate school were more likely to complete graduate study in less time. Providing support that makes it easier to concentrate on course work may be one of the strengths embedded in the training grant model. Particularly for fields where additional postdoctoral training is a highly valued credential, preparing students more quickly to enter this next phase can be viewed as a positive program accomplishment (Geiger, 1997).

Initial Plans Upon Receipt of the Doctoral Degree

After completing the doctorate, the customary next step toward establishing a research career involves either postdoctoral training or a job in which research is a major responsibility. In most biomedical sciences, postdoctoral training has become the Apath most taken.@ It provides an opportunity to augment one=s knowledge and research skills by working with senior scientists and time that is less interrupted by non-research responsibilities (McGinnis, Alllison, & Long, 1982; National Research Council, 1998). In a marketplace that has become increasingly competitive, postdoctoral study also is especially important for those with faculty aspirations. Based on an informal survey of departments in selected fields, more than 80 percent of biochemistry department programs considered previous postdoctoral training a prerequisite for junior faculty (American Association of Universities, 1998). Even in fields where it is not a *de facto* credential for aspiring assistant professors (e.g., nursing and public health), it can nevertheless strengthen one=s credentials in terms of research experience and publications.

This section describes the types of post-Ph.D. positions into which NRSA and comparison group members moved upon completion of their doctoral degree. A closer look at postdoctoral training is then undertaken with regard to: (1) the receipt of NRSA postdoctoral training support within four years of the doctoral degree; (2) overall participation in postdoctoral training regardless of the sponsor; and (3) the extent to which postdoctoral study has functioned more as a buffer against unemployment than as an opportunity for career advancement. Whereas the first two measures are viewed as positive career outcomes, the third represents a possible detour on the road toward becoming an independent investigator.

The First Transition

Continued progress toward a research career B whether postdoctoral training or research-related employment B was assessed, using data collected from new doctorates who had solidified their post-graduation plans.[5] These included individuals who either had signed contracts or made definite commitments with an employer, were negotiating with one or more organizations, or were returning to jobs that they had prior to pursuing doctoral study. Across all cohorts, approximately 93 percent of new biomedical doctorates were moving to postdoctoral study positions or jobs in which research was to be their primary or secondary responsibility.

Whether postdoctoral study or research employment constituted the next step after the Ph.D. did differ among the three groups. Among former NRSA trainees and fellows, 86 percent reported postdoctoral study commitments. The corresponding percentages were nearly 20 percentage points lower for the NIH training institution comparison group (67 percent) and 30 percentage points lower for the non-NIH training institution group (56 percent). These figures were remarkably stable across cohorts and reflect moderate to large differences. Moving to a job with research responsibilities was more frequent among comparison group members B 32 and 25 percent of Ph.D.s from non-NIH and NIH training institutions versus 11 percent of NRSA recipients (see Appendix Table D.4).

These different career decisions may, however, simply reflect differences among disciplines in terms of expected career paths and job opportunities. As previously noted, postdoctoral training has become, for all practical purposes, a prerequisite for obtaining an academic position in such fields as biochemistry. In contrast, based on the advertised availability of and actual appointments to postdoctoral training positions, fields such as

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[5]Postgraduation *plans* rather than *positions actually taken* were examined, given that small sample sizes precluded the conduct of field-specific analyses for type of first job as reported in the Survey of Doctorate Recipients (SDR). These intentions, however, do possess some validity. For 1982 Ph.D.s who responded to the SDR in 1983, the percentage whose postgraduation plans (i.e., postdoctoral study, employment where research was a primary responsibility, or other employment) matched their current position was 85 percent; the corresponding percentage for 1987 doctorates who responded to the 1988 SDR was 80 percent. The correlation between indicating definite plans for postdoctoral study after graduation and reported receipt of postdoctoral training by 1995 was 0.75 ($p < 0.001$) for a sample of 1981-92 biomedical Ph.D.s.

bioengineering, nursing, and public health may view it as beneficial but not mandatory.

To examine the influence of doctoral field on the observed differences, Figure 3.3 displays the planned post-Ph.D. destinations for individuals in three groups of disciplines B those with traditionally high, moderate, and low histories of involvement in postdoctoral study.[6] Two points merit mention. First, pursuing postdoctoral study was consistently more characteristic of the NRSA study group, regardless of the field=s history of participation in postdoctoral training. For example, in disciplines where postdoctoral study was commonplace (e.g., neuroscience and biochemistry), nearly all NRSA recipients (93 percent) reported having made firm postdoctoral study commitments. This was less characteristic of Ph.D.s in the comparison groups (84 and 80 percent of those graduating from NIH and non-NIH training institutions).

Group differences widened for doctorates in fields where postdoctoral study was less the expected career decision after the Ph.D. For disciplines with moderate participation in postdoctoral training, appreciably more NRSA trainees and fellows (80 percent) planned postdoctoral study than either comparison group (61 percent of those from NIH training institutions and 46 percent of those from departments with no NRSA predoctoral training grants). Even in fields where postdoctoral study was relatively infrequent (no more than a quarter of new doctorates planned postdoctoral training), the percentage with definite postdoctoral training plans was double that of the two comparison groups (see Figure 3.3).

The second major observation concerns overall attrition from a research career path (as represented by the white slice of the pie graphs). This was less likely for NRSA-supported Ph.D.s in those fields where postdoctoral training was not the *de facto* career decision upon completing the doctorate. In contrast to the non-NIH training institution group, a *lower* percentage of NRSA predoctoral recipients indicated that their next destination was a job where research was *not* the primary or secondary activity. For fields with histories of moderate postdoctoral study participation, the proportions who reported securing such a position were fairly similar for both NRSA trainees and fellows (4 percent) and their fellow Ph.D.s from the same departments (8 percent) but markedly smaller than that the non-NIH training institution group (15 percent). Looking at those disciplines with traditionally low levels of postdoctoral training, the NRSA-supported Ph.D.s were much less likely than individuals in both comparison groups to have decided on non-research employment (9 versus 23 and 28 percent).

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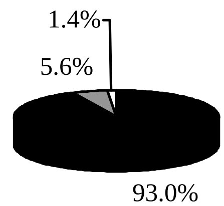
[6]These clusters were an attempt to capture field expectations for and perceptions of the value of postdoctoral training, using the percentages of 1982-92 Ph.D.s who were seeking or had obtained postdoctoral study appointments. Individual disciplines were grouped, based on the extent to which percentages overlapped, using 95 percent confidence intervals. The three clusters consisted of those fields with: (1) traditionally high levels of postdoctoral participation, i.e., at least 70 percent of new Ph.D.s reported seeking or having made definite commitments for postdoctoral study (e.g., biochemistry and neuroscience); (2) moderate levels of postdoctoral participation (fields such as bioengineering and zoology where between 25 and 63 percent of Ph.D.s intended to move to postdoctoral training appointments); and (3) low levels of postdoctoral participation where less than 25 percent of new graduates had postdoctoral study plans (e.g., biostatistics, nursing, and public health). Appendix Table D.5 provides a complete listing of the fields in each cluster.

Figure 3.3

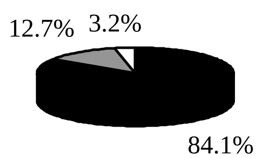
Plans of 1981-92 Biomedical Ph.D.s by Field and Group

Fields with Traditionally High Participation in Postdoctoral Training

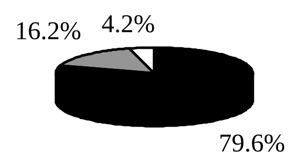
NRSA trainees and fellows



Ph.D.s from NIH training institutions

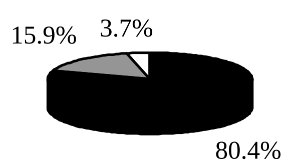


Ph.D.s from non-NIH training institutions

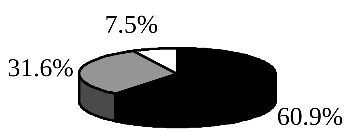


Fields with Traditionally Moderate Participation in Postdoctoral Training

NRSA trainees and fellows



Ph.D.s from NIH training institutions



Ph.D.s from non-NIH training institutions

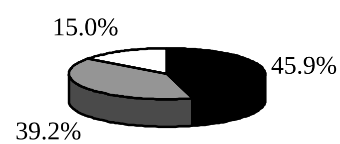
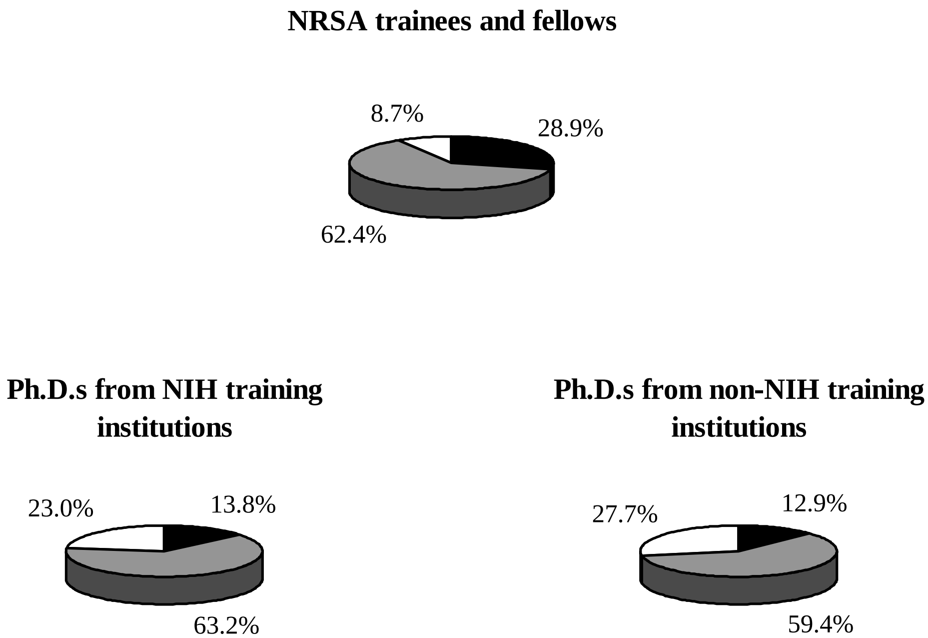


Figure 3.3 (*continued*)
Plans of 1981-92 Biomedical Ph.D.s by Field and Group

Fields with Traditionally Low Participation in Postdoctoral Training



Note. Included are those doctorates with definite commitments at the time of Ph.D. receipt. See Appendix Table D.5.

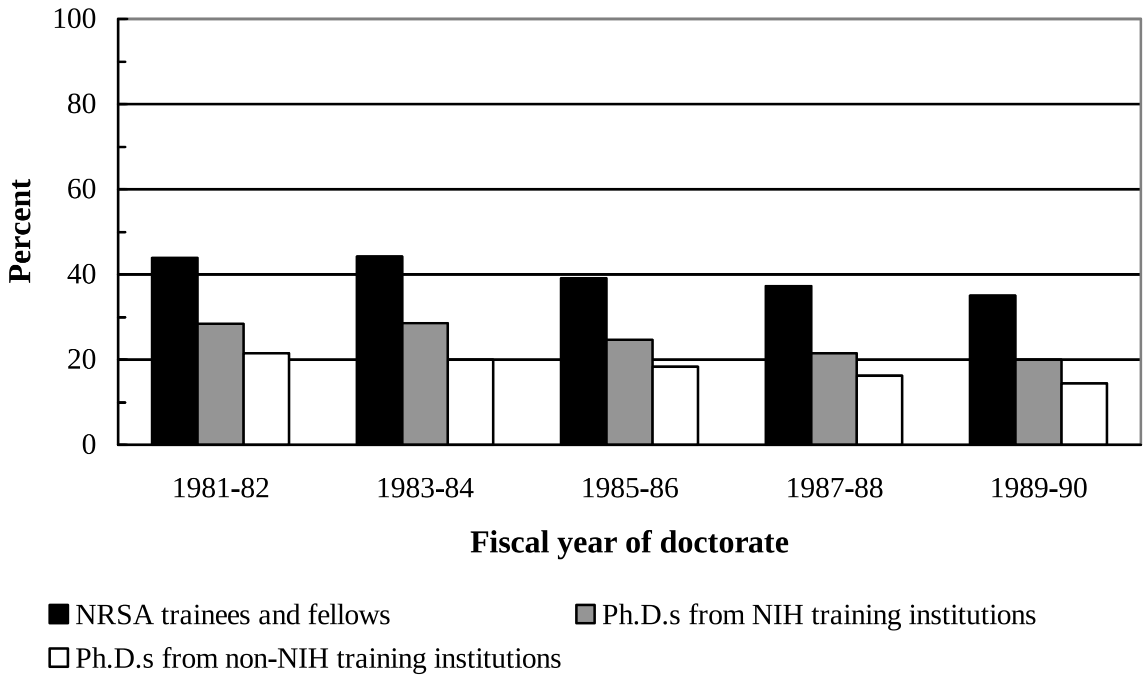
A Closer Look at NRSA Postdoctoral Training

Currently, the federal government is the primary source of support for postdoctoral training, funding approximately three-fourths of all individuals engaged in postdoctoral study (Commission on Professionals in Science and Technology, 1997). Although the majority of these positions are paid by faculty research grants, a healthy fraction of NIH-funded training consists of NRSA postdoctoral traineeships and fellowships. In 1996, the number of positions funded by NRSA programs (about 7,000) slightly exceeded that for research assistant/associate positions on NIH research grants (approximately 6,500).[7] Because NRSA training awards are explicitly designed to provide further *training* in biomedical research, NRSA postdoctoral appointees should reap the benefits associated with further study rather than function as Ahired hands@ on faculty research grants. Indeed, NRSA postdoctoral appointments have been associated with positive career outcomes in research (Garrison & Brown, 1986).

[7]Another 3,000 individuals are supported through the intramural programs, only a small fraction who hold NRSA postdoctoral appointments (F35s).

Across the three groups, approximately 27 percent of biomedical Ph.D.s completed nine or more months of NRSA postdoctoral training within four years of being awarded their degree.[8] Greater involvement, however, was characteristic of NRSA predoctoral trainees and fellows who were more than twice as likely to have held NRSA postdoctoral appointments than individuals graduating from non-NIH training institutions (40 versus 18 percent across all cohorts). The difference was somewhat smaller with respect to individuals from NIH training institutions but still of moderate magnitude (40 versus 25 percent). Although the absolute numbers and the percentages with NRSA postdoctoral awards in each group did steadily inch downward, this did not affect the magnitude of the group differences (see Figure 3.4).

Figure 3.4
Percent of 1981-90 Biomedical Ph.D.s Who Had an NRSA Postdoctoral Training Appointment by Group



Note. Data are from Appendix Table D.6.

Greater participation by NRSA predoctoral awardees in NRSA-supported postdoctoral training can be seen for all broad field groupings (see Figure 3.5). When compared to those without NRSA support, however, field of study did affect the size of the group differences. In disciplines where postdoctoral training is practically a pre-requisite for faculty positions, approximately 44 percent of former trainees and fellows received NRSA

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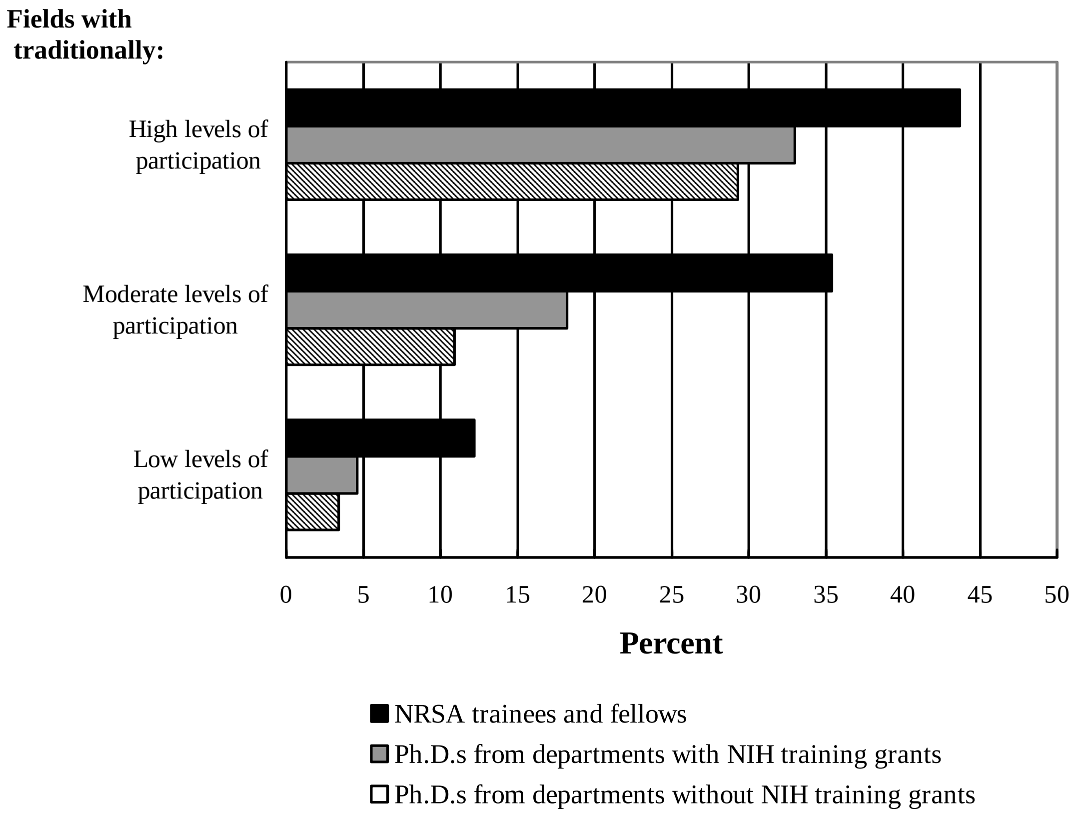
[8]Previous studies have used a more stringent criterion (the postdoctoral appointment must begin in the same calendar year of the doctorate or within 12 months of the degree). Although this should accurately capture postdoctoral training for Ph.D.s, it is less appropriate for M.D./Ph.D.s who typically complete their internship/residency before pursuing postdoctoral study. Because the proportion of dual-degree holders steadily inched upwards in all groups and because dual-degree holders were more concentrated in the NRSA study group, more time was permitted for postdoctoral training to begin.

postdoctoral support as compared to 33 of the NIH and 29 percent of the non-NIH training institution groups. These translate into small but significant differences. For those fields with traditionally low levels of postdoctoral training, the same pattern of differences was observed (although the actual per- centages were smaller in each group). However, for disciplines with moderate fractions of individuals traditionally having some postdoctoral training, larger disparities in favor of the NRSA predoctoral recipients were found. Slightly more than one third (35 percent) of NRSA-supported Ph.D.s received NRSA postdoctoral training, and this proportion was nearly double that of their counterparts from the same training institutions (18 percent) and triple that of those from departments with no NRSA predoctoral training grants (11 percent).

Figure 3.5

Percent of 1981-90 Biomedical Ph.D.s Who Had NRSA Postdoctoral Training by Field=s History of Participation in Postdoctoral Study and Group



Note. Data are from Appendix Table D.7.

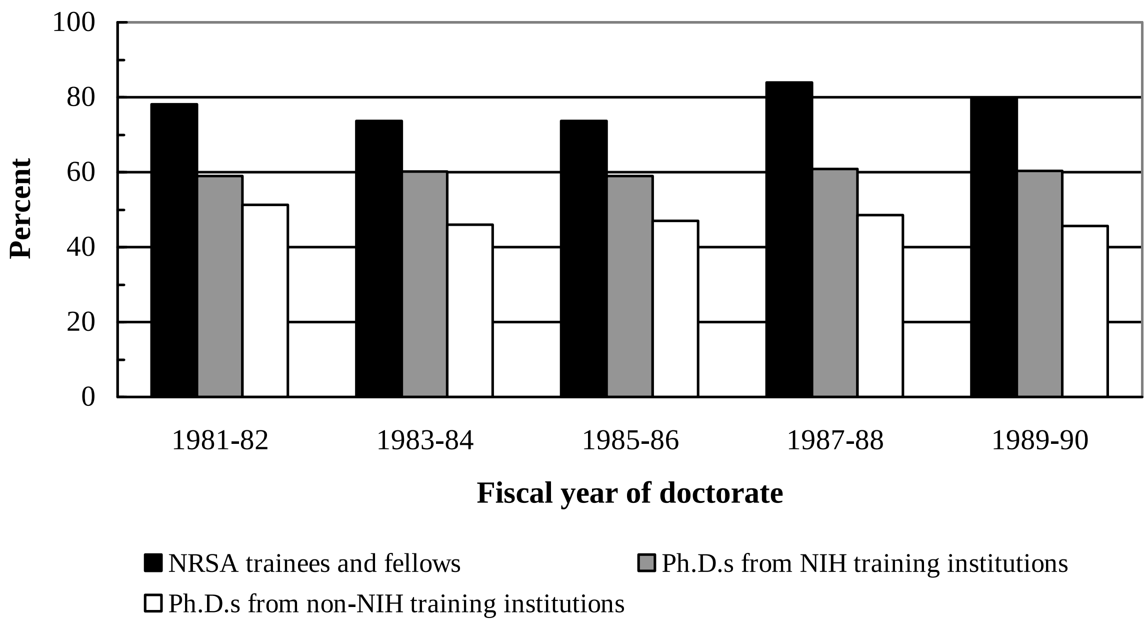
Not only did healthy percentages of former NRSA predoctoral trainees and fellows also have NRSA postdoctoral training, but their share of NRSA postdoctoral awards has been notable. Whereas 29 percent of all FY 1981-92 biomedical Ph.D.s received at least nine months of NRSA predoctoral support, this was true for 43 percent of all NRSA postdoctoral awards made to these cohorts (see Appendix Table D.8). Although the typical practice was to invest in the postdoctoral training of those who had not received NRSA predoctoral support from any Institute, there were some exceptions. The NIGMS more often awarded its postdoctoral traineeships and fellowships to former predoctoral appointees; nearly 80 percent of those with NIGMS-supported postdoctoral training had been supported as a graduate student by an NIH Institute (but typically not the NIGMS). This also was true for the NIMH and the NINR but to a lesser degree B 54 and 64 percent of their postdoctoral awardees had received NRSA predoctoral support. In contrast, the NIA, NIAMS, NIDR, NIDDK, NEI, and NINDS awarded the overwhelming majority of postdoctoral awards (more than 80 percent) to young scientists who had not received NRSA support as graduate students.

Of those whose predoctoral and postdoctoral training were supported with NRSA funds, a large fraction (57 percent) received their support from the same Institute. This practice was the most common among the NINDS, the NINR, and the NHLBI, which provided more than half of their trainees and fellows with both predoctoral and postdoctoral support.

Involvement in All Types of Postdoctoral Training

Although substantial, the NRSA programs remain one among several sources of postdoctoral training support. Thus, data from the 1995 Survey of Doctorate Recipients (SDR) describing *all* types of postdoctoral training were examined. For 1981-90 Ph.D.s, the estimated percentages of individuals who had completed or were currently in postdoctoral training were 78 percent of NRSA trainees and fellows, 60 percent of their counterparts from NIH training institutions, and 48 percent of those from non-NIH training institutions. As shown in Figure 3.6 and similar to the findings regarding postgraduation plans, these percentages translate into moderate-size disparities between NRSA recipients and those from non-NIH training institutions for each cohort. Although both trainees and fellows and their counterparts from the same departments were more likely to report postdoctoral study than Ph.D.s from programs with no training grants, postdoctoral study also was more typical of NRSA predoctoral recipients than even graduate students from the same programs.

Figure 3.6
Estimated Percent of 1981-90 Biomedical Ph.D.s with Postdoctoral Training by Group



Note. See Appendix Table D.9 for information on data sources and group differences.

Factors Affecting the Pursuit of Postdoctoral Training

Given that postdoctoral training has been shown to influence such outcomes as obtaining a tenure-track position and research productivity (e.g., National Research Council, 1974, 1976; Regets, 1998a), a handful of studies has attempted to identify what affects the decision to pursue postdoctoral study. One strong determinant is field of the doctoral degree, with the biological sciences being most likely to acquire additional postdoctoral training (e.g., Regets, 1998b; Zumeta, 1985). Other variables associated with participation in postdoctoral study include graduating from a distinguished doctoral program (McGinnis, Allison, & Long,1982), being primarily supported by a research assistantship in graduate school (Rapoport, 1998), completing the doctorate at a younger age, and spending less time earning the degree.

As described in Chapter 2, the characteristics of the study and comparison groups differed in ways conducive to pursuing postdoctoral study. For example, former NRSA trainees and fellows were younger, and they graduated from more highly regarded biomedical programs. They also were more likely to earn doctorates in fields where postdoctoral study is the conventional choice. Consequently, the contribution of NRSA predoctoral support over and above these other factors is not clear.

Using the data on prior and current postdoctoral training from the 1995 Survey of Doctorate Recipients (SDR), logistic regressions were performed to predict the proportion of Ph.D.s who had been involved in some type of postdoctoral training.[9] In addition to being an NRSA predoctoral trainee or fellow, potential explanatory variables included those mentioned above, along with other variables thought to possibly bear on the decision to acquire postdoctoral training (see Appendix Table D.10).[10]

The strongest predictor of postdoctoral study was field of the doctoral degree (see Figure 3.7). Compared to disciplines where postdoctoral training is not expected after degree completion, new doctorates in fields with histories of high involvement in postdoctoral training were more likely to have completed a postdoc even after holding all other variables constant. Where NRSA training support may make the most difference becomes sharper when field and other variables are taken into account (see Figure 3.7). In those disciplines characterized by moderate or low levels of postdoctoral participation, involvement in postdoctoral training by former trainees and fellows was 10 - 12 percentage points higher than that for Ph.D.s from departments with and without NRSA predoctoral training grants. Smaller differences, although in the same direction, were found for doctorates trained in fields where postdoctoral training clearly is the expected career path. Here, the proportions were 5 percentage points higher for NRSA predoctoral recipients as compared to members of both comparison groups.

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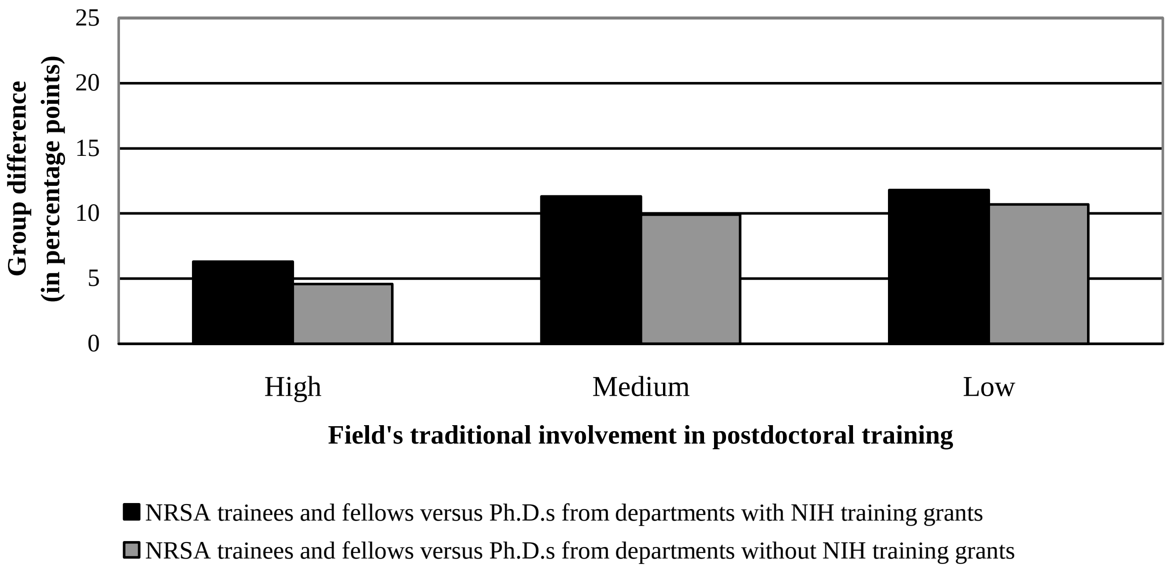
[9]These regressions examined involvement in any type of postdoctoral training (e.g.,an NRSA traineeship, a research assistantship on an NIH or NSF grant, or a fellowship from the American Cancer Society). Statistical tests indicated that none of the predictors significantly affected the odds of having an NRSA-supported postdoc versus having one=s training supported by another source (Long, 1997).

[10]These included: (a) being a member of an underrepresented minority group, which often has been associated with differential employment patterns that may result from differential involvement in postdoctoral training; (b) earning a B.A.from a highly selective institution; (c) earning a Ph.D. and a M.D., which requires additional clinical training to practice medicine at any level and may postpone postdoctoral study; and (d) Astrength@ of the labor market as measured by the percentage in a field with definite commitments at the time of graduation. Once again, doctoral field was grouped into the three clusters identified as having high, moderate, or low levels of postdoctoral participation. These groupings were used in order to reflect Aexpectations@ and traditional career paths for a discipline. Because of multicollinearity problems with age at the time of the Ph.D. and time-to-degree, only age at entry into a graduate program was used.

Other variables also influenced the decision to seek additional postdoctoral training in the expected direction. For example, financing one=s doctoral study through outside employment significantly reduced the likelihood of postdoctoral study. The same was true for taking time out between beginning graduate study and receiving the doctorate (e.g., working for some period of time between earning a master=s degree and enrolling in a doctoral program) and for taking additional time to complete the Ph.D. Being older when first beginning graduate study also decreased the probability of having a postdoctoral training appointment when comparing NRSA trainees and fellows to their counterparts from institutions without NIH training grants.

Figure 3.7

Adjusted Group Differences in Pursuit of Postdoctoral Training by Field=s Traditional Involvement in Postdoctoral Study: 1981-90 Biomedical Ph.D.s



Note. Data are based on the regression model reported in Appendix Table D.6. The differences pertain to the percentage of each group having postdoctoral training, holding all other variables at their means.

It was the case, however, that controlling for these other factors did decrease the overall role of NRSA predoctoral support. Instead of accounting for nearly 8 percent of the variance in postdoctoral training between the NRSA study group and those from non-NIH training institutions and 3 percent when looking at the NIH training institution group, having an NRSA traineeship or fellowship accounted for 1 percent.

Nevertheless, this greater participation in postdoctoral study by former trainees and fellows is noteworthy. If postdoctoral training functions as intended, it should help to improve one=s later chances of becoming an independent investigator by acquiring additional research skills, experience, and publications. These benefits can then increase the odds of obtaining academic and other employment in environments conducive to conducting research and continue progress toward establishing a research career.

Postdoctoral Training C A Career Move or Holding Pattern?

Several recent studies have described the lengthening of postdoctoral study in the biological sciences. It has been the case, however, that the most marked changes occurred during the 1970s. For example, the fraction of life science Ph.D.s who held postdoctoral training appointments 3-4 years after graduation increased sharply between 1973 and 1981, rising from 7 to 24 percent; since then, it grew more slowly, reaching 31 percent in 1995 (National Research Council, 1998). Similarly, whereas the median length of time spent in postdoctoral training grew from 28 months for 1965-74 doctorates to 38 months for 1975-84 doctorates, it was 46 months for 1989-91 cohorts (Regets, 1998b).

This extension of the postdoctoral training period has been viewed by some as indicative of a weakening labor market where those facing bleak job prospects choose or continue in postdoctoral appointments (Garrison & Gerbi, 1998; Magner, 1998; National Research Council, 1998). The degree to which this applied to former trainees and fellows and their comparison group counterparts was examined, using the length of and reasons for pursuing postdoctoral study reported by respondents to the 1995 SDR.

Overall, no consistent and significant group differences in the total months spent in postdoctoral study were found. On average, NRSA trainees and fellows spent 47 months in postdoctoral study versus 45 and 42 months for Ph.D.s from NIH and non-NIH training institutions. However, this does not directly address the question of remaining in postdoctoral appointments as a function of a stagnant marketplace.

Although there are few guidelines as to the appropriate amount of postdoctoral training, the American Association of Universities (1998) recommended that six years be the maximum time spent as a postdoctoral fellow. The percentages in each group who indicated having more than six years of postdoctoral training or who identified the lack of available jobs as the primary reason for accepting a postdoctoral appointment are presented in Table 3.1. Across all cohorts, a slightly smaller proportion of former trainees and fellows (16 percent) found themselves in one or both of these situations as compared to those in the comparison groups (20 percent). Thus, it does not appear that the greater involvement by former trainees and fellows in postdoctoral training can be traced to encountering more problems in the marketplace than their comparison group counterparts.[11]

Summary

Based on the available data, the postgraduation step for Ph.D.s who had received NRSA predoctoral training support is consistent with continued progress toward establishing a research career. As would be expected, the nature of this step C further training or actual research-related employment C depended on the field of study. However, regardless of differences among disciplines with respect to involvement in postdoctoral training, former NRSA trainees and fellows more often chose this path. In addition, larger proportions of NRSA-supported doctorates also received NRSA postdoctoral traineeships and fellowships B a clear indication of continued training and involvement in health-related research.

Although the differences were more visible between NRSA predoctoral recipients and Ph.D.s from non-NIH training institutions, they did not disappear when contrasting NRSA trainees and fellows with doctorates from departments without NRSA predoctoral training grants. Furthermore, the contribution of such predoctoral support remained significant, albeit small in magnitude, after other variables that influence the decision to undertake postdoctoral training were taken into account.

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[11] Individuals also may have been either reluctant to report staying in postdocs because of the inability to locate suitable employment or are less apt to respond to the survey.

Table 3.1

Estimated Percentages of 1981-88 Biomedical Ph.D.s with More than Six Years of Postdoctoral Training or Who Accepted a Postdoctoral Appointment Because of No Job Prospects

Group		Fiscal Year of Doctorate 1981-82	1983-84	1985-86	1987-88	Total
More than 6 years of postdoctoral study						
NRSA predoctoral trainees and fellows	%	14.1	10.8	11.8	12.5	12.2
Ph.D.s from NIH training institutions	%	11.1	14.0	15.0	16.7	14.2[c]
Ph.D.s from non-NIH training institutions	%	9.1	14.9	7.6	9.7	10.3
Postdoc accepted due to poor job prospects						
NRSA predoctoral trainees and fellows	%	4.2	5.5[a]	5.2[a]	9.3	6.2[a]
Ph.D.s from NIH training institutions	%	9.3	7.3[b]	8.1	8.0	8.2[c]
Ph.D.s from non-NIH training institutions	%	9.4	16.5	12.4	14.8	13.2
Either of the above						
NRSA predoctoral trainees and fellows	%	17.7	14.0[a]	14.1	17.7	15.9[a,b]
Ph.D.s from NIH training institutions	%	18.7	19.1	19.8	22.0	19.9
Ph.D.s from non-NIH training institutions	%	18.0	27.5	18.0	18.2	20.3
Estimated total *n*s						
NRSA predoctoral trainees and fellows		178	182	196	218	774
Ph.D.s from NIH training institutions		174	154	177	175	680
Ph.D.s from non-NIH training institutions		140	126	128	142	536
Total, all groups		492	462	501	535	1,990

Note. Data are from the NRC Doctorate Record File (1994), the NSF 1995 Survey of Doctorate Recipients, and the NIH Trainee and Fellow File (1994). The NRSA group includes those who had at least nine months of F32, F35, or T32 predoctoral support. To be considered a postdoctoral appointment, study had to begin no earlier than 12 months before the individual=s last doctoral degree but no later than 4 years after degree receipt and be at least nine months in duration. All *n*s are sample estimates.

[a] The difference between the NRSA and the non-NIH training institution groups was significant.
[b] The difference between the NRSA and the NIH training institution groups was significant.
[c] The difference between the NIH and the non-NIH training institution groups was significant.

Overall, large majorities of study and comparison group members either pursued postdoctoral study or secured research-related employment upon completion of their degree. For those who chose to take postdoctoral training positions, the length of postdoctoral training has increased. This has been viewed as a sign of a weak labor market (National Research Council, 1998). Both NRSA predoctoral fellows and their comparison group counterparts spent between 3.5 and nearly 4 years, on average, in postdoctoral study, and between 10 and 14 percent reported postdoctoral training periods of more than six years. At the same time, the NRSA study group was significantly less likely to indicate that they had accepted a postdoctoral training appointment because no suitable employment was available.

In general, the greater percentage of NRSA trainees and fellows who pursued postdoctoral study suggests continued progress toward a research career, given that former postdocs in the biological sciences have been more likely to obtain tenure-track positions than those who did not acquire such training (Regets, 1998a). Thus, it appears that individuals who had NRSA predoctoral support made a career decision that was consistent with strengthening their qualifications for pursuing a research career in academe.

Employment and Research Careers

The initial career choice of newly minted Ph.D.s does not necessarily guarantee the establishment of a long-term research career. As described in the previous section, postdoctoral training is commonplace in the biomedical sciences. The obvious question then becomes AWhat happened after this training was completed?@ For those who reported having accepted a job at the time of graduation, the data indicate that the majority of these positions were research-oriented. However, these responsibilities may have shifted in later years, and individuals may have obtained different positions that focused on activities other than research.

Previous evaluations of the NRSA predoctoral programs have shown that former NRSA trainees and fellows pursued careers in research but at no greater rates than other biomedical scientists, particularly those who graduated from the same departments (Coggeshall & Brown, 1984; National Research Council, 1977). Given the numerous factors that affect job placement, this finding is not surprising. However, the economy, availability of research funds, and job opportunities for young biomedical scientists in the 1980s were not availability of research funds, and job opportunities for young biomedical scientists in the 1980s were not identical to those experienced by earlier cohorts. Consequently, employment outcomes were compared for FY 1981-88 Ph.D.s, using data from the NSF biennial survey of doctoral scientists and engineers (SDR).

Because career paths are not the same for biomedical investigators in different disciplines, it is not clear at what point after the Ph.D. employment outcomes should be assessed. Although the optimal strategy would be to identify individuals= first Acareer path@ job and subsequent shifts over time, this is difficult to carry out with the existing survey data.[12] In this evaluation, seven to eight years was selected as a reasonably fair comparison point, given the frequent involvement in postdoctoral study for biomedical scientists and the typical length of such training (an estimated 60 percent of biomedical scientists reported spending 4 or more

[12] Changes in survey design and execution limit the comparisons that could be performed, along with their interpretation. For example, beginning with the 1991 survey, the sample size was reduced due to funding constraints, the incorporation of more concerted follow-up efforts resulted in considerable reduction of non-response as compared to previous years, and revisions in question wording occurred. These and other modifications affect the precision and quality of the survey estimates and thus the ability to distinguish actual changes in outcomes over time from methodological artifacts. However, the SDR remains the major source of national-level employment data for members of the study population and provides useful information.

years in such study). Due to the small number of cohorts with available data, the numerous factors that can contribute to later career outcomes (or lack thereof), and the increased difficulty of detecting effects that occur several years after the receipt of NRSA support, employment at subsequent time points was not examined.

Type of Employment Setting

During the time period covered by the four surveys (1989-95), the marketplace for biomedical researchers underwent certain changes. One noticeable shift was a marked increase in academic positions that were Aoff-track@ (e.g., contract faculty and senior postdocs with research staff titles) but considerably less growth in positions for tenure-track and tenured faculty (Garrison & Gerbi, 1998; Hackett, 1990). Opportunities in industry, after expanding dramatically between 1981 and 1989, remained relatively stable.

Looking at 1981-88 doctorates, approximately 53 percent were working in academic institutions 7-8 years after completion of their doctorate. Of this group, an estimated three fifths (63 percent) had tenure-track or tenured positions. Business and industry employed another 26 percent, and the remainder (21 percent) was scattered across a diverse group of work settings (e.g., government, hospitals, and nonprofit organizations).

The settings in which former trainees and fellows were working did not differ significantly from those of their comparison group counterparts (see Figure 3.8). Across all cohorts, nearly three fifths (57 percent) had jobs in academic institutions as compared to 52 percent of their fellow Ph.D.s from the same departments and 56 percent of those from departments without NRSA predoctoral training grants. Depending on the group, between 25 and 29 percent had jobs in business and industry, and the remainder was employed in other nonacademic settings (e.g., government and hospitals).

Looking more closely at academic positions, the fractions with nonfaculty or Aoff-track@ positions were remarkably similar B about one fifth of the biomedical scientists in each group were working as research staff at university-based research institutes or had faculty appointments that were not designated as tenure-track (e.g., research assistant professors). However, having a tenure-line faculty appointment was more characteristic of former NRSA trainees and fellows. Seven to eight years after their Ph.D., an estimated 39 percent were either tenure track or tenured faculty, and this proportion fluctuated little among the four cohorts (see Appendix Table D.11). This figure was, on average, about 10 percentage points higher than that for their fellow graduate students who did not have NRSA predoctoral support and seven percentage points higher than that for individuals from departments with no NIH training grants.

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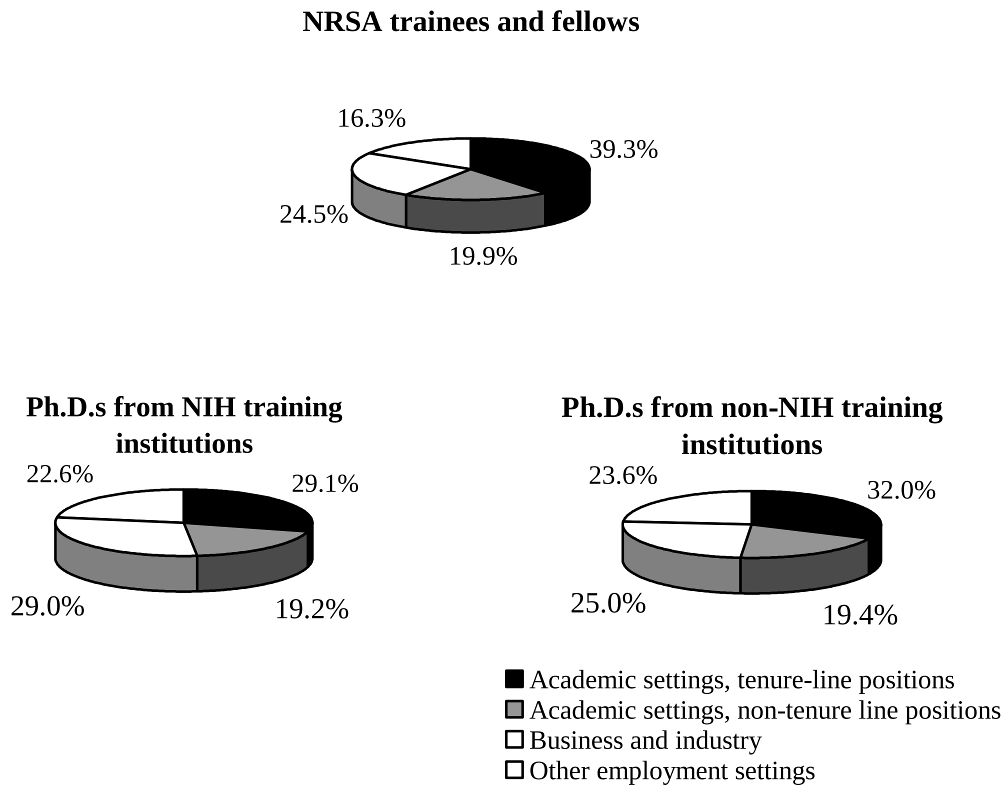
Figure 3.8
Estimated Percentages of Employed 1981-88 Biomedical Ph.D.s in Various Work Settings 7-8 Years Post-Ph.D. by Group

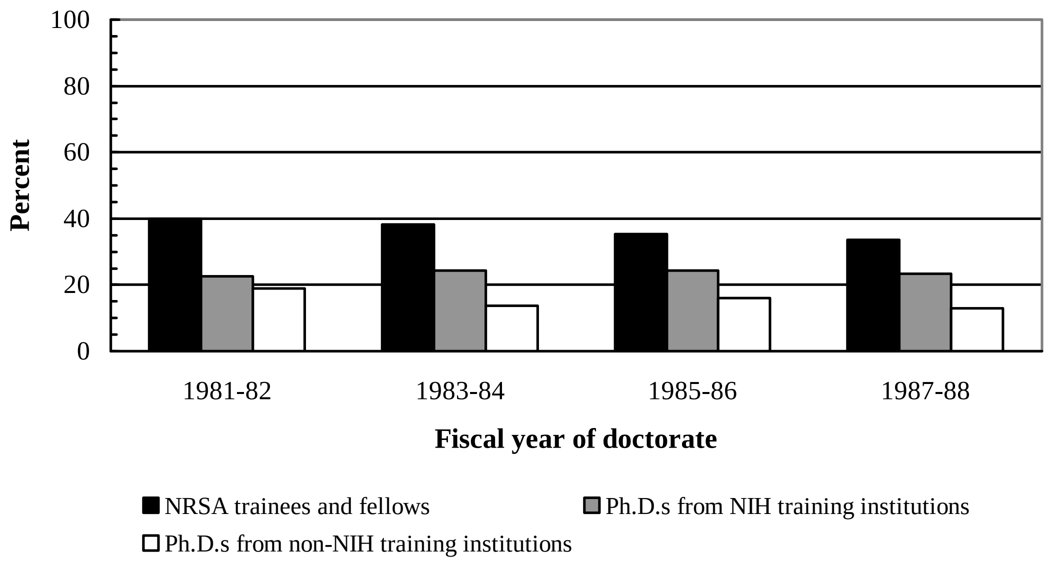


Note. Data are from Appendix Table D.11. Both full-and part-time employed individuals are included. The percentages represent the average percentage across the four surveys. Because of differences in methodology between the surveys conducted prior to 1991 and thereafter, additional analyses were performed that excluded the 1981 cohort (whose data were gathered in the 1989 survey); however, the results were not appreciably different.

Faculty Positions in Institutions with Distinguished Biomedical Doctoral Programs

The positions occupied by the NRSA-supported Ph.D.s also were more likely to be in institutions ranked in the top quartile of those with doctoral programs in the biomedical sciences (see Figure 3.9). Across the four cohorts, an estimated 37 percent of NRSA recipients held faculty appointments in these research-intensive organizations; corresponding percentages for the NIH and non-NIH comparison groups were significantly lower at 23 and 16 percent, respectively (see Appendix Table D.12). Furthermore, the magnitude of these group differences was reasonably consistent across the four cohorts.

Figure 3.9
Estimated Percentages of 1981-88 Biomedical Ph.D.s Who had Positions in the Top Quartile of Institutions with Doctoral Programs 7-8 Years Post-Ph.D. by Group



Note. Data are from Appendix Table D.12. Because of the changes to the survey methodology in 1991, the estimates for the 1981-82 cohort who responded in 1989 should not be directly compared to those for later cohorts.

Factors Influencing Type and Location of Academic Employment

It is well-known that factors such as field and postdoctoral training play a role in the type of career path jobs which individuals obtain. Given that the trainees and fellows were more likely to graduate from prestigious institutions and pursue postdoctoral study than their comparison group counterparts, the role of NRSA predoctoral support over and above these other factors was examined. Logistic regressions were performed to identify the key predictors of having such a position in 1995.[13] In addition to NRSA predoctoral training, these variables included several that have been previously found to influence working at a top-ranked academic institution, including the reputation of one=s Ph.D.-granting institution and years of postdoctoral training.[14]

However, few emerged as significant predictors. After controlling for other variables, members of underrepresented minority groups were more likely to hold such positions. The same was true for individuals who earned their degree in a shorter amount of time. Having NRSA predoctoral training support contributed over and above these other variables in accounting for the higher percentages of trainees and fellows working

[13]The 1995 SDR was chosen inasmuch as it was the only survey that collected data on previous receipt of postdoctoral training across all sponsors and settings such as industry and faculty research grants).

[14]Predictors were gender, being a member of an underrepresented minority group, age at the time of the Ph.D., graduating from a highly selective baccalaureate institution, major field and year of the Ph.D., quality of the institution awarding the degree, time-to-degree, having an NRSA or other type of postdoc, and length of postdoctoral training.

at distinguished academic institutions as compared to Ph.D.s from departments without NIH training grants. Although statistically significant, however, its contribution was small (less than 1 percent of the variance).

Employment in Research-Related Positions

Because academic institutions are not the only settings where biomedical scientists can function as an independent investigator, the extent to which individuals had any type of research-oriented job also was examined. Here, *research positions* were defined as those in: (a) institutions of higher education with one or more biomedical doctoral programs ranked in the 1995 Research Doctorate Study (Goldberger, Maher, & Flattau, 1995); and (b) business, industry, government, and other nonacademic settings where research was reported as the individual=s primary responsibility.[15] Postdoctoral training appointments were excluded. Figure 3.10 presents the percentages of employed biomedical scientists in such roles 7-8 years after their degree.

Although most Ph.D.s held research-related jobs, this was even more characteristic of the NRSA study group. Across all cohorts, an estimated 87 percent of the NRSA predoctoral recipients held such positions as contrasted with 77 and 72 percent of individuals from NIH and non-NIH training institutions. With the exception of the 1985-86 cohort where the NRSA recipients and their institutional counterparts performed equally as well and better than those from non-NIH training institutions, this pattern suggests that individuals with NRSA predoctoral training remained more likely to be part of the biomedical research work force 7-8 years after completing their doctorate.

The consistent retention of NRSA predoctoral recipients in research careers also is evident at other career stages. As of 1995, larger proportions of NRSA trainees and fellows were in research-related positions, regardless of whether the doctorate had been earned 1-2, 3-4, or even 13-14 years earlier. Considering both the research-based employment described above *and* postdoctoral training as indicative of being in a research career track, Figure 3.11 shows that with the exception of those whose doctorate was earned 9-10 years earlier (i.e., the 1985-86 cohort), larger percentages of those with NRSA-supported graduate study occupied research-oriented positions. Across all cohorts, an average 83 percent of former NRSA trainees and fellows held such appointments. This figure was 7-12 percentage points higher than those for the two comparison groups. Although small in magnitude, these differences are not inconsequential in light of the NRSA training objective for producing biomedical researchers.

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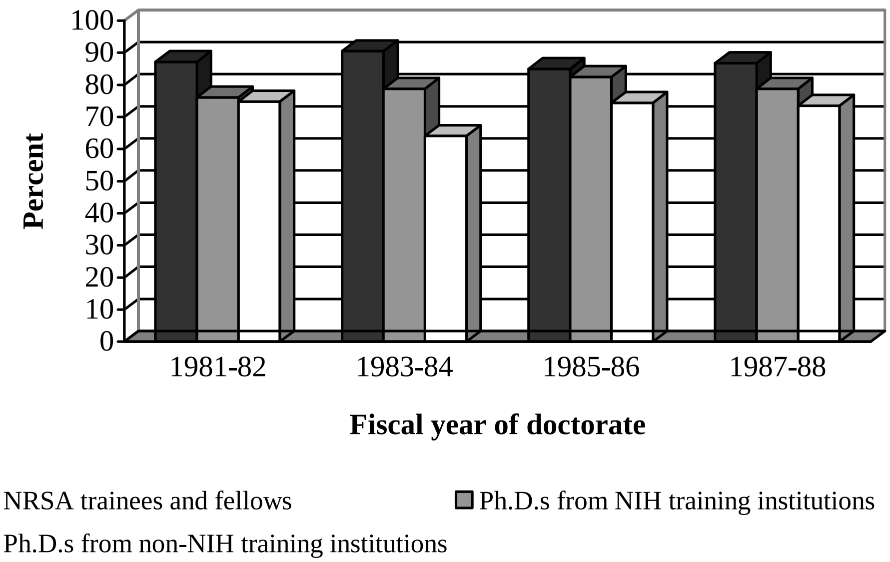
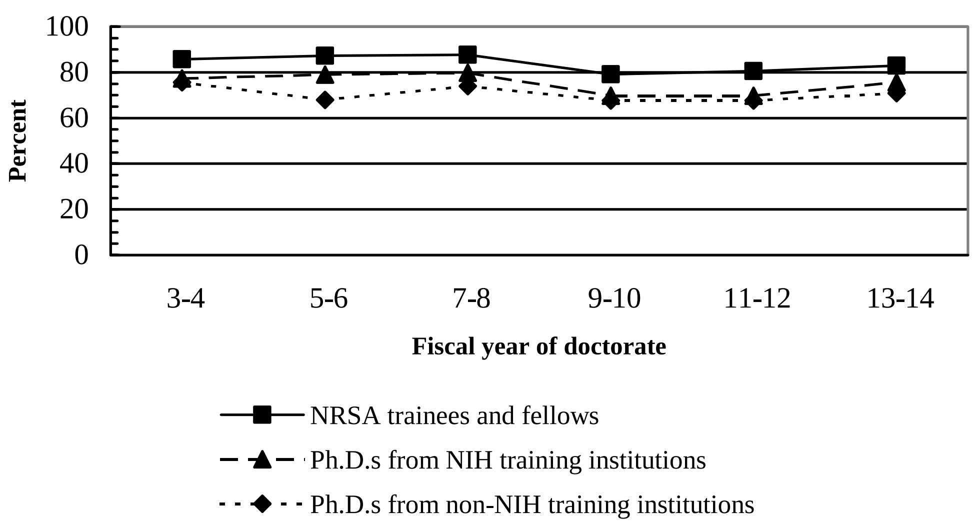
[15] In developing this measure, several alternative definitions were explored, based on the available survey data. Using research as the primary activity for nonacademic settings eliminated the fewest percentage of individuals but performed less well for identifying appropriate positions in academic institutions. Because research is an important component of biomedical Ph.D. programs, employment in such an institution seemed a reasonable criterion for identifying a research-oriented academic setting. Unfortunately, the data did not allow linking an individual with a specifically ranked program, which causes some unknown amount of error since the faculty position could be in a nondoctoral program in another discipline. However, a review of the data revealed showed that those academic employers of respondents who were not in this group were typically liberal arts colleges and non-doctoral granting institutions, the majority of which are less actively involved in research.

Figure 3.10
Estimated Percentages of 1981-88 Biomedical Ph.D.s Who Were Employed in a Research-related Position 7-8 Years Post-Ph.D. by Group



Note. Data are from Appendix Table D.13. Research-related positions are ones in academic institutions with at least one ranked biomedical research doctorate program and nonacademic jobs where research is the primary responsibility. Because of changes in the survey, the estimates for the 1981-82 cohort who responded in 1989 should not be directly compared to those for later cohorts.

Figure 3.11
Estimated Percentages of 1981-92 Biomedical Ph.D.s Who Were Employed in a Research-related Work or Training Position by Group and Career Stage



Note. Data are from Appendix Table D.14. Included are both research-related employment and postdoctoral training.

Summary

The results of these analyses support the continued progression of NRSA predoctoral trainees and fellows in research careers. Although an estimated four-fifths of all biomedical Ph.D.s landed research-oriented positions in either academic or nonacademic settings 7-8 years after their degree, this was more characteristic of those with NRSA-supported predoctoral training. In contrast to their comparison group counterparts, those receiving NRSA support also were more likely to have obtained academic positions commonly associated with career advancement and promotion (i.e., tenure line appointments). This was particularly true for those earning their degrees in the early 1980s. Furthermore, these positions were more often in universities with highly-ranked doctoral programs in the biomedical sciences. These are settings that are actively involved in research, value research as a key faculty responsibility, and have the resources to facilitate obtaining external research support B all aspects that are conducive to building an independent research program.

Analyses examining what was responsible for these outcomes identified only a small role for NRSA predoctoral support in obtaining faculty positions in research-intensive institutions, and its contribution was limited to explaining differences between trainees and fellows and doctorates who graduated from departments without NIH training support. This suggests that the training provided by high-quality doctoral programs helped students compete more successfully in the academic job market B training that was provided to both NRSA trainees and fellows and their fellow graduate students whose studies were supported by other sources.

It must be remembered that there are several other ways in which Ph.D. scientists can contribute to the research enterprise (e.g., managing research programs, communicating the results of research to non-scientists, and designing science-based curriculum for precollege and undergraduate students). These were not explored in this report. At the same time, the primary objective of the NRSA programs is to produce biomedical investigators. With the exception of one cohort (1985-86 Ph.D.s), NRSA-supported Ph.D.s in various career stages were more likely than either comparison group to be in a research-related position (employment or postdoctoral training) in 1995. Although most doctoral programs in the biomedical sciences share this goal, those with NRSA training grants appear to do a slightly better job in preventing departures from this career path.

Seeking and Obtaining External Research Support

Establishing a program of research is clearly one crucial element in beginning a career as a biomedical scientist. For those at academic institutions, it is contingent upon actively pursuing external research support. Tenure, promotion, and annual performance reviews of faculty consider research grants and contracts an obvious sign of productivity, and for non-tenure research positions, salaries are paid primarily by such outside support. Moreover, strong publication records C another standard against which researchers are judged B are difficult without the funds to support the needed empirical work.

This section examines the application and award histories of study and comparison group members with regard to NIH and NSF research grants. Before describing each group=s performance, some caveats are necessary. First, as previously mentioned, these measures of research progress are most applicable to those in academic institutions who comprise the largest group of applicants for research grants (Pion, Schaffer, Seder, Marks, & Bouchard, 1999). Scientists who work in such settings as industrial and federal laboratories also may be actively leading research efforts; however, this is difficult to determine from available data sets.

Second, the NIH and NSF are not the only sources of funding for biomedical research. In recent years, industry has surpassed government in actual research expenditures (National Research Council, 1994). A recent survey of FY 1994 applicants to the NIH also found that nearly half (47 percent) received research support as principal investigators from sponsors other than the NIH, and among those who did not have NIH research support, 24 percent had other active research grants (Pion et al., 1999). At the same time, the NIH remains the major federal sponsor of biomedical research, awarding more than $9 billion in research grants in FY 1997 (National Institutes of Health, 1998). In the life sciences, the NSF also serves as a significant source of research support. Thus, an NIH or NSF research grant can be considered one measure of success as a biomedical researcher.

Third, because NIH and NSF application and award data track only individuals who apply as principal investigators, they do not fully capture involvement in even the research projects that they fund. Approximately 7 percent of unsuccessful applicants for NIH research support were involved in another key role on an NIH research grant, and another 2 percent held such positions on non-NIH funded projects (Pion et al., 1999). This situation may be more typical of individuals in the early stages of their careers, e.g., new faculty may initially collaborate with other faculty on multiple-investigator projects. Individuals in non-faculty, research positions (e.g., research associates) also may be precluded by employer policies from applying as an independent investigator. Thus, the percentages who obtain research grants underestimate the number who are involved in NIH and NSF sponsored research.

Finally, the majority of analyses are restricted to the 1981-88 cohorts. This is due to the substantial involvement of biomedical Ph.D.s in postdoctoral training and the resulting delay in applying for external funding. In all groups, the median length of postdoctoral study was estimated at nearly four years, and the median length from receipt of the doctorate to first NIH or NSF application ranged from 53 to 55 months. As such, seeking and attracting research support may not occur until six years after Ph.D. receipt. Because funding data were current through FY 1994, comparisons were restricted to individuals whose doctorate was earned no later than 1988.

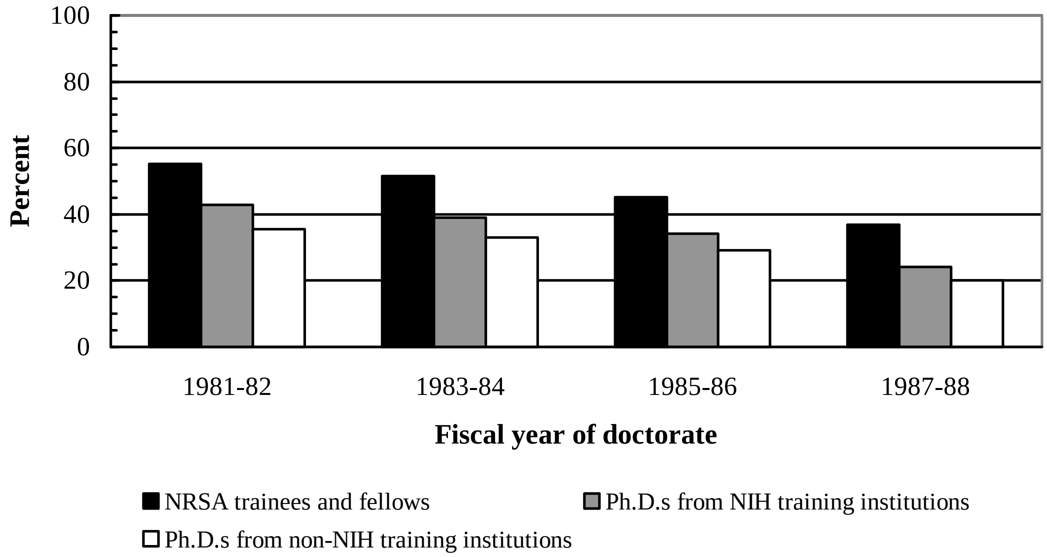
Application to the NIH and the NSF

Figure 3.12 presents the percentages who had applied for their first NIH or NSF research grant by FY 1994. As previously noted, these figures inched downward in all groups, partly as a consequence of the shorter amount of time to apply for recent cohorts. Nevertheless, it remained more likely that NRSA predoctoral trainees and fellows had pursued NIH or NSF support. Of the 1981-82 cohort, 55 percent of the NRSA study group had applied as compared to 43 and 36 percent of those from NIH and non-NIH training institutions. Corresponding percentages for 1987-88 biomedical Ph.D.s were 37, 24, and 20 percent, respectively. These proportions, despite their downward trend across cohorts, produced group differences that were reasonably consistent in magnitude. In other words, the *differential* performance of those with NRSA predoctoral support did not erode over time. Disparities also were larger between the NRSA trainees and fellows and each comparison group than between the two comparison groups that did not receive NRSA predoctoral support.

Application rates within seven years of the doctoral degree were examined to avoid the influence of differing time to apply for support (see Figure 3.13). Approximately 40-45 percent of the NRSA study group in each cohort had applied to the NIH or NSF within seven years of their doctoral degree. This figure was typically 10 percentage points higher than those who graduated from NIH training institutions (26-35 percent) and 15 percentage points higher than the other comparison group (22-28 percent).

Figure 3.12

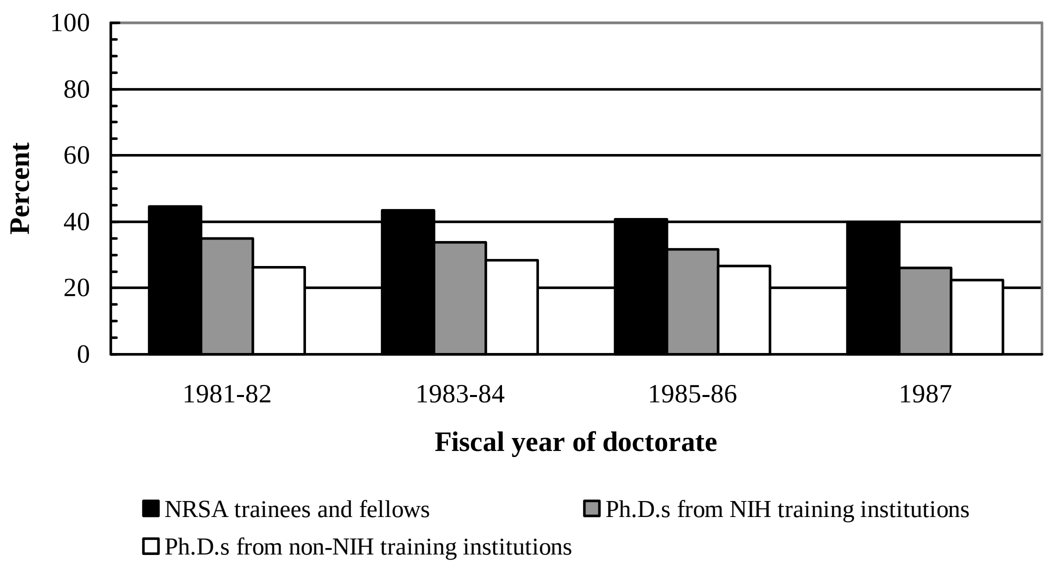
Percent of 1981-88 Biomedical Ph.D.s Who Applied for an NIH or NSF Research Grant as of FY 1994 by Group



Note. Data are from Appendix Table D.15.

Figure 3.13

Percent of 1981-88 Biomedical Ph.D.s Who Applied for an NIH or NSF Research Grant Within 7 Years of Receiving Their Doctorate by Group

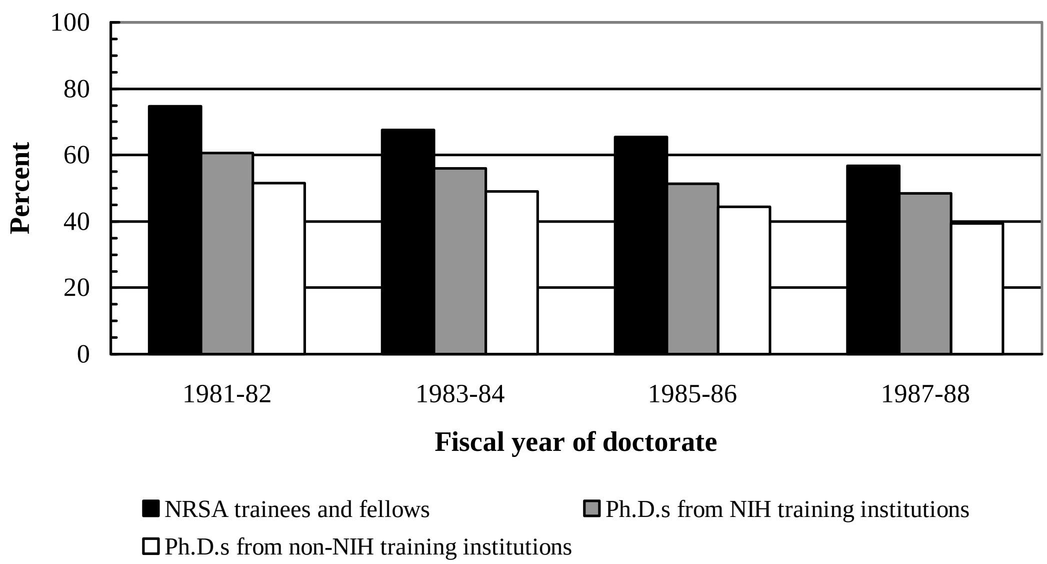


Note. Data are from the NIH Consolidated Grant Applicant File (1995).

Success Among Applicants in Obtaining External Research Support

Figure 3.14 compares the success of applicants in securing NIH and NSF research support.[16] Similar to application rates, the percentage in each group and the differences between study and comparison group members were affected by the time available for application, review, and award. Once again, however, NRSA-supported Ph.D.s outperformed their comparison group counterparts. Among 1981-82 Ph.D.s, approximately 75 percent of former NRSA trainees and fellows had been awarded one or more Research Project Grants (RPGs) by FY 1994 as contrasted with 61 percent of Ph.D.s graduating from the same departments and 52 percent who earned their degree from departments without NIH training funds. For 1987-88 doctorates, these figures were 57, 49, and 39 percent, respectively. Those comparisons that allowed the same length of time to elapse (seven years) from Ph.D. receipt indicated a similar rank-ordering among groups and greater success for NRSA recipients (see Figure 3.15).

Figure 3.14
Percent of 1981-88 Biomedical Ph.D.s Who Applied for and Were Awarded an NIH or NSF Research Grant as of FY 1994 by Group

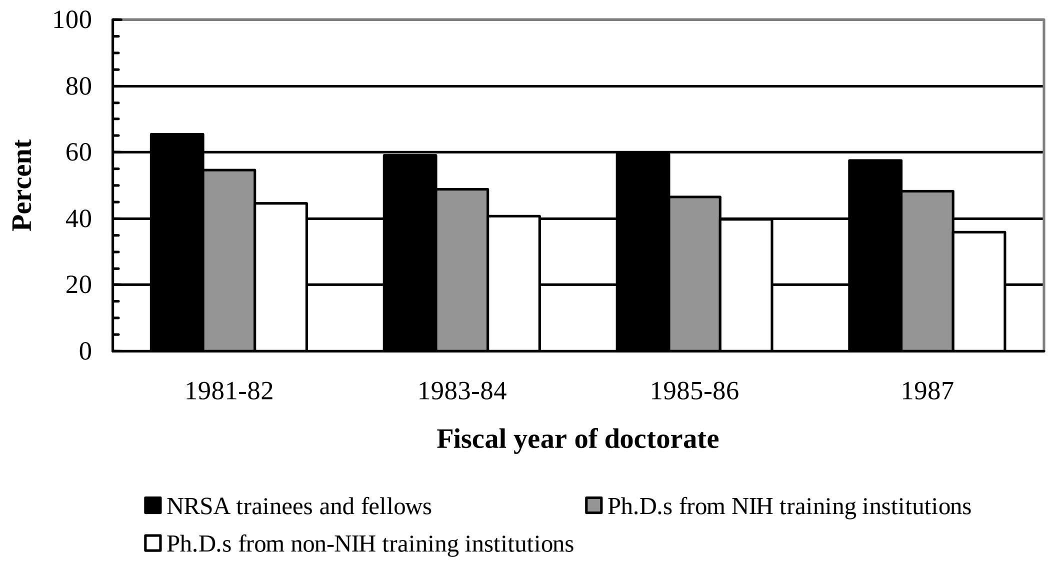


Note. Data are from Appendix Table D.16

[16] Analyses were also done on award rates (the percent of all Ph.D.s who were awarded funds regardless of whether they applied) but are not reported as the direction, significance, and magnitude of the group differences were nearly identical to those for success rates.

Figure 3.15

Percent of 1981-88 Biomedical Ph.D.s Who Applied for and Were Awarded an NIH or NSF Research Grant Within 7 Years of Receiving Their Doctorate by Group



Note. Data are from the NIH Consolidated Grant Applicant File (1995).

It is well-known that competition for extramural research support intensified during the time period when the study population was most likely to actively begin pursuit of external research support B that is, after their four years of postdoctoral training (typically about four years) or 1985 and thereafter. At the NIH, the overall success rate for competing research program grants (RPGs), although somewhat variable, dropped by almost 8 percentage points from 33 percent in FY 1985 to 25 percent in 1994 (National Institutes of Health, 1995). A similar trend occurred in the success rate for first-time applicants. For example, although 50 percent of applicants to the NIH are eventually successful in obtaining some type of funding, the percent of those who receive an award in the same year of their application (and thus able to begin working on their chosen research program) declined from 27 percent in 1986 to 21 percent in 1994.

This increasingly competitive environment may have affected the progress of young biomedical scientists in the early stages of establishing an independent research program. The percentage whose application was funded within 12 months of its first submission was examined for each group (see Figure 3.16).[17] As can be seen, a consistent pattern of differences was observed among the three groups B one that favored NRSA predoctoral recipients.[18] The largest disparity was between former trainees and fellows and

[17]Because the actual submission date for an application is not part of the data system, this should not be interpreted as 12 months from an application deadline. Rather, it represents the time between review of the application and the grant start date. This was calculated as the difference between the months elapsed from time of PhD to first RPG award (as indicated by the start date for the project) and months from time of Ph.D. to first RPG application, using the Initial Review Group date.

[18]These percentages are higher than those reported by the NIH for first-time investigators who are funded in the same fiscal year of their application. Some of the difference is attributable to the different population, e.g., exclusion of MDs and behavioral scientists, along with how the figures were calculated.

Figure 3.16
Percent of Biomedical Ph.D. Applicants Whose NIH Application was Funded Within 12 Months of its First Review by Group

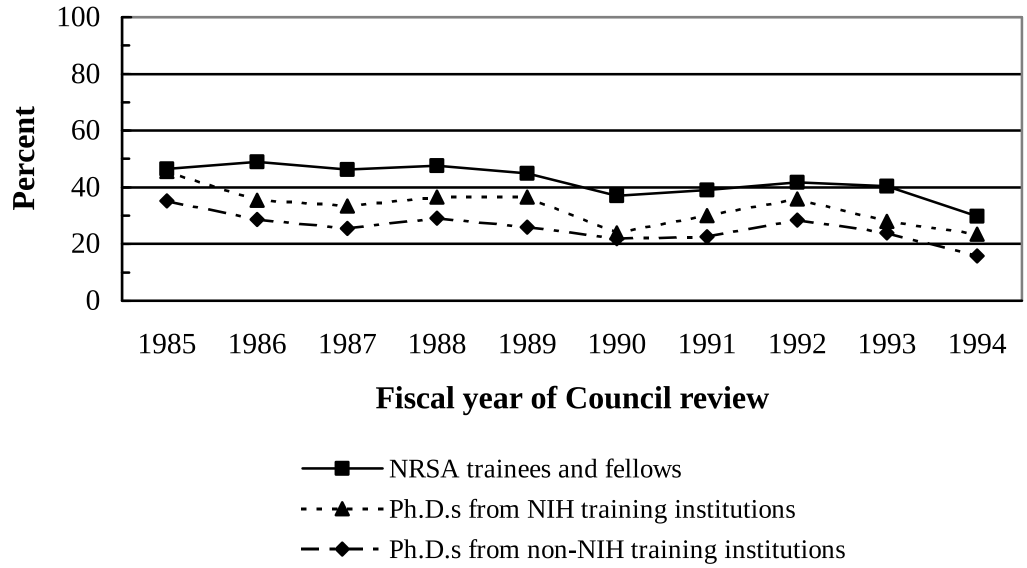
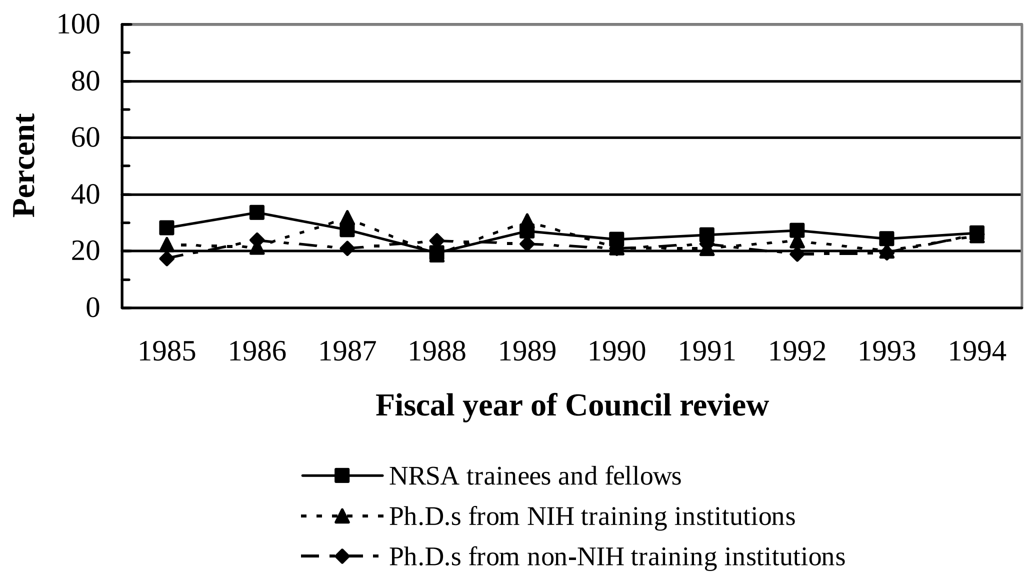


Figure 3.17
Percent of Biomedical Ph.D. Applicants Whose NSF Application was Funded Within 12 Months of its First Review by Group



Note. Data on NIH and NSF applicants are from Appendix Tables D.17a and D.17b, respectively.

Ph.D.s from non-NIH training institutions; nearly 42 percent of NRSA recipients, on average, were funded within 12 months as compared to 26 percent of this comparison group. Smaller differences, albeit significant, were found when comparing the NRSA study group with their graduate school counterparts from the same departments where one-third, on average, were funded within a similar period of time. As Figure 3.17 indicates, this pattern was not observed for NSF awards. The reasons for this are not clear, but they may include the differences in applicants= research fields and topics (e.g., the life sciences) and the review processes (e.g., a greater use of mail review by the NSF) between the two agencies.

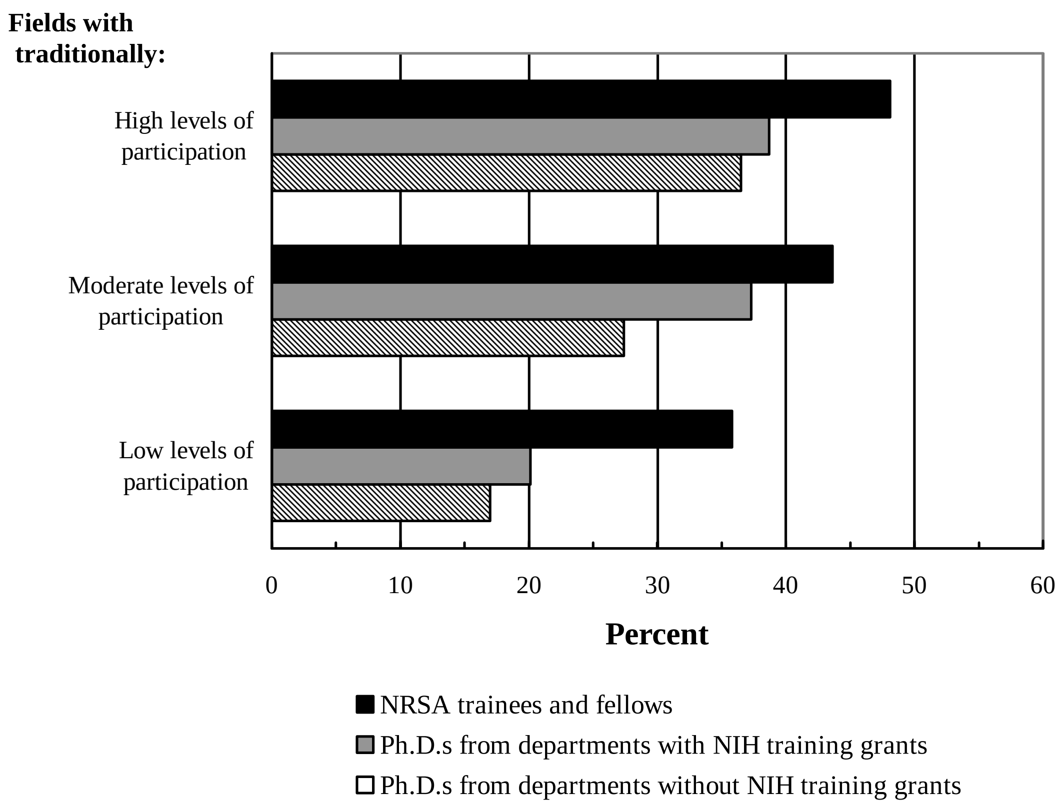
Differences in application and award rates among fields. The higher application and success rates of former NRSA trainees and fellows may, in part, stem from group differences in their degree field. For example, the time to first application depends on whether time is spent in postdoctoral training, and one=s success in obtaining a position within an academic setting B the environment most conducive to seeking external support. Decisions to seek funding from the NIH or NSF and the success in obtaining are dependent on agency research priorities and funding resources. All these vary among disciplines. Because the distributions of Ph.D. fields were not the same for the study and comparison groups, application and award rates were examined separately for fields with different levels of postdoctoral training histories. Although degree field is a reasonably crude indicator of investigators= research programs, these clusters do take into consideration broad differences in research problems and approaches and the likelihood of postdoctoral study B one primary factor that may affect the time before one=s first application (and award).

In those fields where postdoctoral training has been essentially a criterion for subsequent academic employment (e.g., biochemistry, genetics, and neuroscience), approximately 37 percent of all FY 1981-88 Ph.D.s had submitted at least one application to either agency by FY 1994. This proportion was slightly lower for doctorates in disciplines with moderate postdoctoral training participation and markedly lower for fields in which postdoctoral training was relatively infrequent (21 percent).

Figure 3.18 documents the submission of at least one application by major field. For all three clusters, application rates were higher in the NRSA study group, especially when compared to those graduating from departments with no NRSA predoctoral support. The disparity was greatest in those disciplines whose graduates less frequently pursued postdoctoral study such as nursing and public health; the percentage of NRSA predoctoral recipients applying for research funds (36 percent) was nearly double that of those from the same departments (20 percent) and more than twice that of Ph.D.s from programs lacking NIH training grants (17 percent).

For the other two areas, the general ordering of groups on application rates was the same, but the magnitude of the differences was smaller. In fields where postdoctoral training participation has been more mixed (e.g., general biological sciences, parasitology, and toxicology), about 44 percent of former trainees and fellows had submitted a grant application as compared to 27 percent of Ph.D.s from different programs; however, it was only 7 percentage points greater than the rate of Ph.D.s applying from the same departments (37 percent). In fields where postdoctoral training is commonplace, application rates were essentially similar for both comparison groups (39 and 37 percent) and 10 - 12 percentage points lower than NRSA predoctoral study recipients (48 percent).

Figure 3.18
Percent of 1981-88 Biomedical Ph.D.s Who Applied for an NIH or NSF Research Grant by FY 1994 by Field Cluster and Group

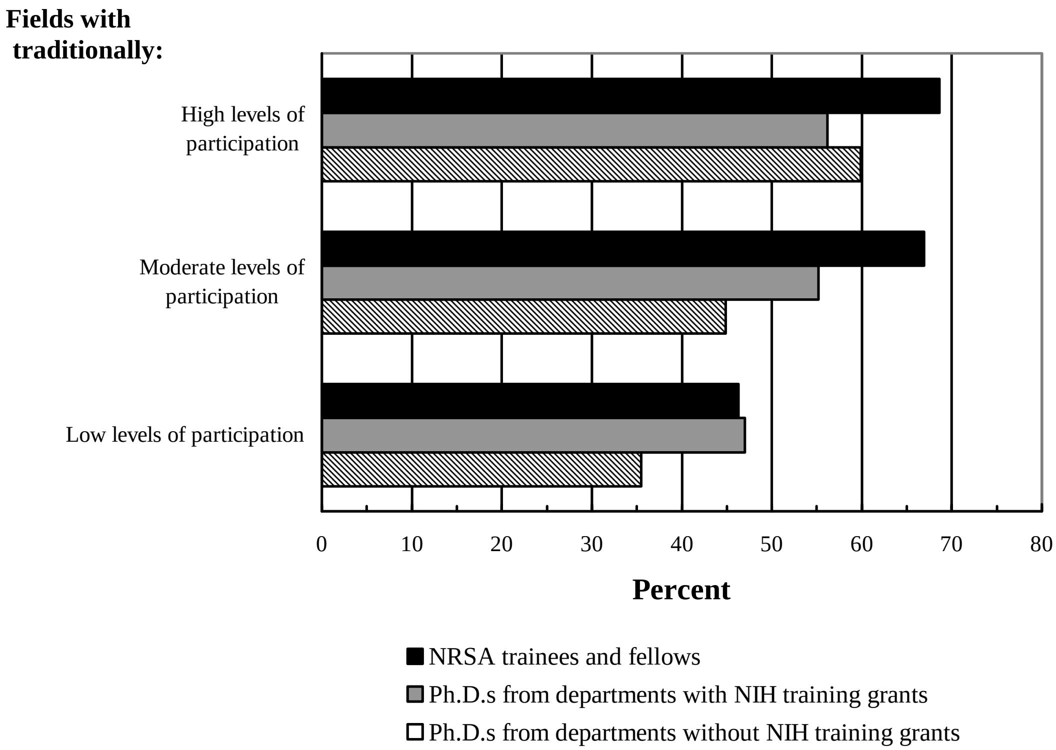


Note. Data are from Appendix Table D.18a.

Having applied, the likelihood of receiving at least one award by FY 1994 also differs by field (see Figure 3.19). Overall, success rates were 60 and 54 percent for disciplines with high and moderate postdoctoral training levels as compared to 36 percent for such fields as nursing, public health, and pharmacy. In the first two clusters, those with NRSA predoctoral training were more likely to have received NIH or NSF funding than those from non-NIH training institutions, with the discrepancy greatest for fields with moderate levels of postdoctoral study. For example, whereas 67 percent of NRSA trainees and fellows in fields with moderate histories of postdoctoral study had successfully obtained funding by FY 1994, this was true for only 45 percent of their counterparts from non-NIH training institutions. Similar, albeit smaller, differences were found for Ph.D.s who graduated from the same departments as the NRSA study group but were not NRSA trainees or fellows (55 percent). Looking at fields where postdoctoral appointments are customary, the success rate was 69 percent for the NRSA study group versus 56 and 51 percent for individuals from the same and different departments, respectively. In contrast, for those in fields where the minority of new graduates pursues postdoctoral study, the performance of NRSA predoctoral recipients and their departmental counterparts was nearly identical (46-47 percent), both of which were significantly higher than the success rates for doctorates from non-NIH training environments (36 percent).

Figure 3.19

Percent of 1981-88 Biomedical Ph.D. Applicants Who Were Awarded an NIH or NSF Research Grant by FY 1994 by Field Cluster and Group



Note. Data are from Appendix Tables D.18a and D.18b.

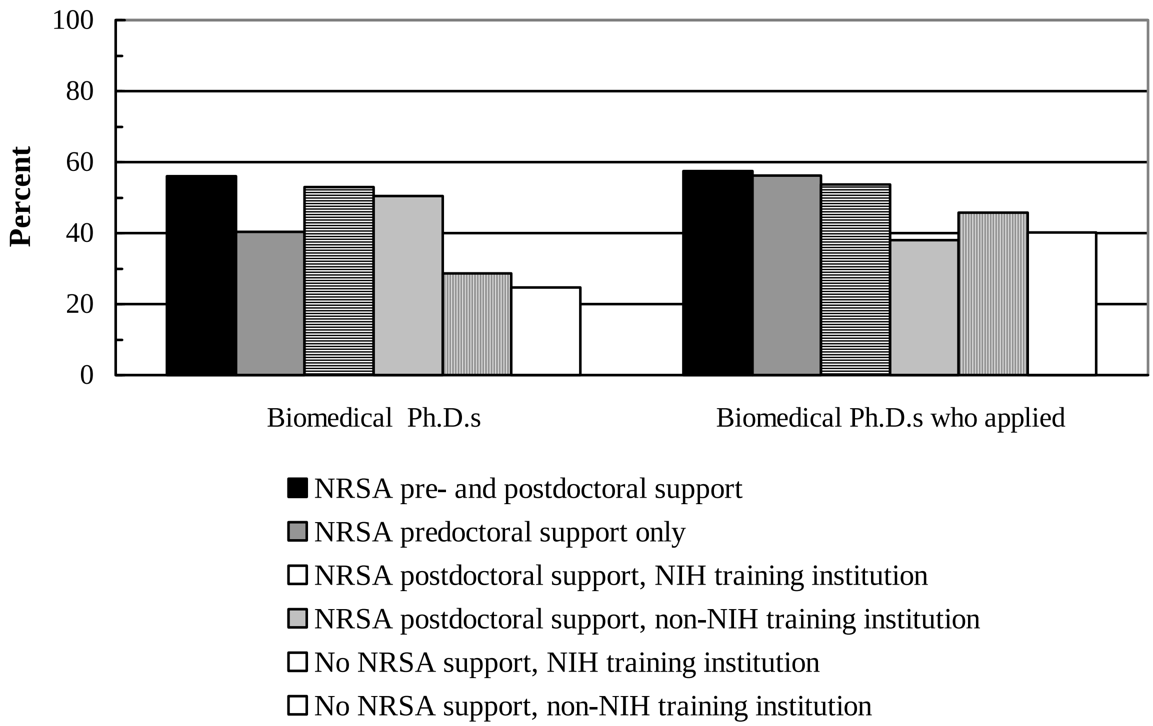
The Role of NRSA Postdoctoral Training

The above results are based on analyses which cluster disciplines by their history of participation in postdoctoral study. They suggest that postdoctoral training itself may contribute to differential experiences in seeking and obtaining external research support. As reported earlier, a larger percentage of NRSA predoctoral trainees and fellows had one or more postdoctoral appointments. Thus, the observed group differences favoring the NRSA study group may also be associated with this additional training. Because some individuals in the comparison groups had postdoctoral traineeships and fellowships, this may have reduced the magnitude of the observed differences. Thus, additional comparisons were made by further stratifying each of the three groups into those who did and did not receive NRSA postdoctoral training support. NRSA-funded postdoctoral study was used as these were the only data available for all members of the study and comparison groups; in this way, the postdoctoral training received may have been more associated with interest and training in health-related research areas.

One might speculate that those with both types of NRSA training would be more likely to pursue biomedical research careers (and apply for grants) and successfully establish a program of research as an independent investigator (i.e., be awarded research funds). Although it is not clear that those with either NRSA predoctoral support or postdoctoral support would perform differently, both should outperform those with no such training B whether because of inherent ability, the quality and resources of the institutions at which they receive this training, or additional expertise acquired from participation in NRSA-supported training. The issue of talent also is somewhat indirectly addressed by comparing those in the same support category (predoctoral versus postdoctoral) but who earned Ph.D.s from different types of institutions (NIH and non-NIH training institutions).

The results are depicted in Figure 3.20. With regard to application rates, two points are worth noting. First, having *any* NRSA-supported training B predoctoral, postdoctoral, or both B was associated with higher application rates. Moderate to large differences favoring those with NRSA pre- and postdoctoral support, NRSA predoctoral training, or NRSA postdoctoral training were found when comparing them to individuals with no such support. Across all cohorts, 56 percent of NRSA predoctoral trainees and fellows who also received NRSA postdoctoral training support had applied for one or more NIH or NSF research grants by FY 1994. The corresponding percentages for those who were not predoctoral trainees or fellows but who held such appointments at the postdoctoral level were not markedly different B 53 and 51 percent for Ph.D.s from the same or different departments than the NRSA predoctoral recipients. The proportion was noticeably lower for individuals with only NRSA-supported graduate training (40 percent) but was still nearly twice as large as those for doctorates who had neither predoctoral nor postdoctoral support. Here, 29 and 25 percent of Ph.D.s from the same departments and from those without NIH training grants had submitted one or more applications.

Figure 3.20
Percentage of 1981-88 Biomedical Ph.D.s Who Applied for an NIH or NSF Research Grant and Percentage of Applicants Who Were Awarded Funds by Type of NRSA Support and Doctoral Training Institution



Note. Data are from Appendix Table D.19.

Second, Figure 3.20 displays the strong association between NRSA postdoctoral training and applying for NIH or NSF research funds. Depending on the group of interest, application rates were 11 to 16 percentage points higher for individuals who had been NRSA postdoctoral trainees or fellows. In addition, this relationship appears to be affected little by the quality of the Ph.D.-granting institution. That is, those with NRSA postdoctoral training, regardless of their doctoral program=s reputation, applied at nearly identical rates.

This pattern was somewhat different when looking at being awarded an NIH or NSF research grant. Here, the ordering of groups suggests that NRSA predoctoral and postdoctoral support, along with the prestige of the doctoral institution, were related to success in obtaining research funds. Those with both NRSA pre- and postdoctoral training (69 percent) or only NRSA predoctoral support (65 percent) were most likely to have been awarded funds by FY 1994. A close third were doctorates from the same departments as former predoctoral trainees and fellows and whose postdoctoral training was supported by NRSA funds (61 percent). The success rate of individuals from programs without NIH training grants but who managed to be awarded an NRSA postdoctoral traineeship or fellowship was 8 percentage points lower (53 percent)and was similar to that of Ph.D.s with no NRSA training support and typically degrees from prestigious institutions (51 percent). Finally, only 44 percent of applicants with degrees from departments without NIH training grants and who did not have an NIH-funded postdoctoral training had been awarded an NIH or NSF research grant.

This differential pattern in award rates when all NRSA-supported research training experiences are taken into account, coupled with the results from the analyses among different PhD fields, cannot be readily explained by the simple comparisons. Consequently, multivariate analyses were performed to examine the influence of several factors that may contribute to the observed group differences.

Factors Associated with Application and Success Rates

Because application and success rates appeared to differ partly as a function of degree field and involvement in NRSA postdoctoral training, the influence of these other variables was examined in more detail. Logistic regressions were again used to examine both application and success rates, controlling for not only cohort, field, and postdoctoral training but also other factors that may affect the successful seeking of external research support. Along with demographic characteristics and selectivity of undergraduate and doctoral institutions, the regressions examined employment in an academic tenure line or non-tenure line position B the location of most applicants B and whether this employer was a major performer of biomedical research (as indicated by being in the top quartile of institutions with biomedical doctoral programs). Also included were the primary source of graduate support and years enrolled in graduate school, all of which may play some role in initial career choices regarding postdoctoral training and employment.

These analyses were based on those 1981-88 biomedical doctorates who responded to the 1995 Survey of Doctorate Recipients; using this sample allowed consideration of postdoctoral training sponsored by all types of sources and reported employment since the doctorate. Once again, examination focused on the four earliest cohorts so as to allow a reasonable length of time to complete any postdoctoral training, obtain subsequent employment, and apply for and receive a research grant.[19]

[19] Analyses showed that the mean number of years from the Ph.D. to the first NIH research grant application was six years.

Application rates.[20] Applying for an NIH or NSF research grant is best predicted by having NRSA-supported or other postdoctoral training and by having a tenure-track or tenured position at an academic institution (see Appendix Table D.20). For individuals who had received NRSA postdoctoral training awards, approximately 54 percent had sought such research support, and the proportion was only slightly smaller for those whose postdoctoral study had been financed in other ways (49 percent). However, a small fraction (20 percent) of biomedical Ph.D.s who had not had postdoctoral training had applied by FY 1994. As can be seen in Figure 3.17, the differences that emerged for those with NRSA predoctoral appointments as compared to their counterparts without such support were small and within sampling error (not statistically significant).

Not surprisingly, applications more frequently came from those with faculty positions. Whereas 70 percent of tenure-line faculty had sought such research support, this was true for 36 percent of those in Aoff-track@ academic positions and 14 percent in nonacademic settings. Postdoctoral training, regardless of whether it was supported by NRSA funds, also was influential. When these and other factors were taken into account, the additional contribution of NRSA predoctoral support was minimal. Essentially, the observed differences in application rates stemmed from increased involvement in any type of postdoctoral training and obtaining a tenure-line faculty position.

Success rates.[21] Once again, a small group of variables contributed to the observed differences between the study and its two comparison groups (see Appendix Table D.21). Having had a tenure-track or tenured faculty position had the most visible influence on the likelihood of applicants being awarded one or more research grants. In fact, the greater tendency for former trainees and fellows to have had postdoctoral training than those from departments with no NIH training grants (83 versus 66 percent, respectively) appeared responsible for a significant fraction of the observed differences in success rates between these two groups. As shown in Figure 3.21, once this factor and other variables had been controlled for, the percentage point disparity in success rates was significantly reduced. The role of NRSA predoctoral support was only marginally significant ($p < 0.06$). In contrast, having a traineeship or fellowship still was a reliable predictor for the differential success rates between trainees and fellows and their counterparts who graduated from the same departments, accounting for 3 percent of the variance after controlling for other variables.

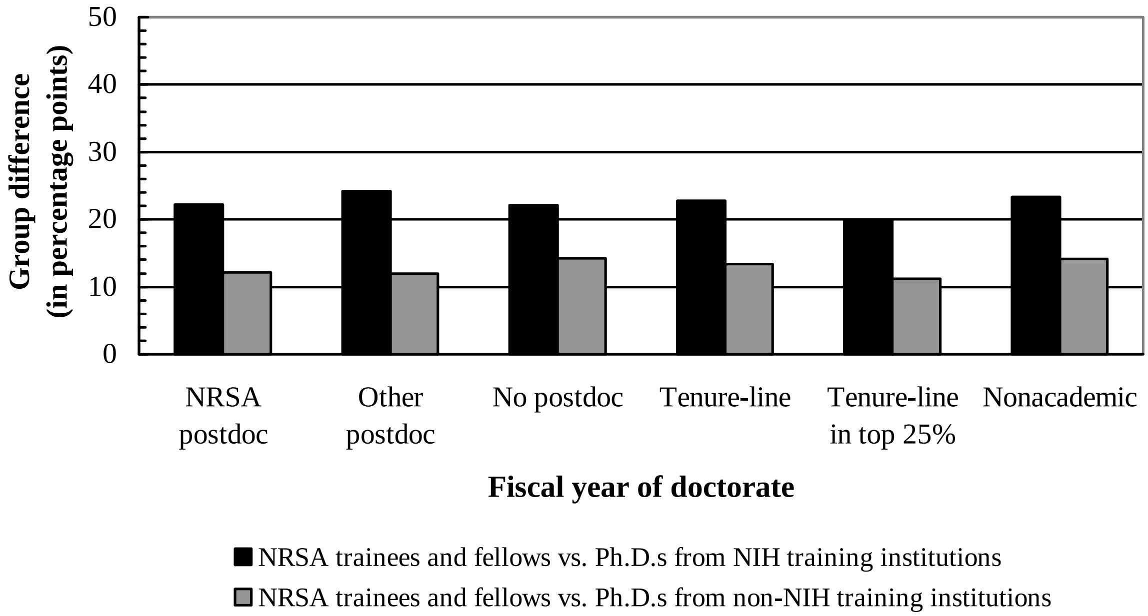
Summary

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. In addition, former NRSA trainees and fellows appeared more successful in obtaining these research funds on their first attempt, thus, avoiding the need to prepare time-consuming resubmissions to the NIH. The enhanced performance of NRSA-supported Ph.D.s, when contrasted with the track records of doctorates from non-NIH

[20]The sample percentages, based on the respondents to the 1995 survey, were reasonably similar to those for the populations in each group (i.e., 47 percent for trainees and fellows, 35 for Ph.D.s from the same department, and 30 percent for those from different departments). With the exception of the non-NIH training institution group, the differences were within the bounds of sampling error. In the latter case, however, respondents appeared to be slightly more likely to have applied to the NIH/NSF, which may underestimate the differences from trainees and fellows.

[21]With the exception of the NRSA study group, these rates were similar to those for the entire population and within the boundaries of sampling error. The success rate for NRSA predoctoral trainees and fellows was slightly higher (76 percent).

Figure 3.21
Adjusted Success Rates for 1981-88 Biomedical Ph.D. Applicants by Type of Postdoctoral Training Support and Employment



Note. Appendix Table D.21 describes the regression model from which these adjusted differences were derived.

training institutions, was fairly consistent across different disciplinary groups, but somewhat more field-dependent when considering those from the same institutions as the NRSA recipients. However, part of these differences, particularly in application rates, was accounted for by having had an NRSA postdoctoral training appointment.

Additional analyses, incorporating field of Ph.D., pursuit of postdoctoral training, and other factors likely to affect application and success rates (i.e., type of employment), helped to explain the differences between groups dramatically. Consequently, having an NRSA traineeship or fellowship did not significantly account for the group differences over and above this and other factors.

More substantial differences, all else being equal, were observed for success rates where an estimated 71 percent of NRSA trainees and fellows who applied received one or more awards compared to 56 and 44 percent in the two comparison groups. Once again, the observed differences between former trainees and their fellows from departments without NIH training grants were narrowed considerably after taking into account having a faculty position, postdoctoral training, and other variables. In contrast, NRSA predoctoral support remained a significant predictor for the stronger performance of the NRSA study group as compared with its fellow graduate students from the same departments.

Publication Activity in the Early Career Stages

Publication and citation counts are commonly used measures for assessing research productivity of individual scientists, research training programs, research laboratories and other organizations, and even countries (e.g., Goldberger, Maher, & Flattau, 1995; National Science Board, 2000; Sonnert & Holton, 1996). The reasons are several B numbers of publications and reference to them in other published works possess high face validity as indicators of research involvement, are more direct than such variables as employment setting and primary work activity, and, in contrast to successful grantsmanship, can apply to individuals in most setting where research is conducted.[22] Bibliometric data bases are less vulnerable to self-report problems (e.g., reactivity or inaccurate recall of information to questions on employment or career achievements) and nonresponse, two issues that can affect survey data. Their expanded inclusion of disciplines also has enhanced the utility of publication output measures (unlike measures of research funding for which relevant data are not available for all sponsors). This is not to say that these measures are error-free, however; for example, their focus on published articles in journals makes them less relevant in examining fields where books and book chapters are recognized forms of scholarship, and difficulties in accurately attributing articles to authors, particularly for individuals with common names or name changes, are a source of measurement error.

At the same time, counts of journal articles and citations to them are acknowledged indicators of research involvement. It is fairly well-accepted that journals have served as the classic channel for communicating scientific advancements, and the high acceptance rate of many journals make articles a legitimate indicator of whether one is conducting research (Miller & Serzan, 1984). Furthermore, publication measures have demonstrated high convergent validity with other measures of research accomplishments (Narin, 1976; Sonnert, 1995).

In the following sections, publication counts and citation rates are compared for a probability sample of study and comparison group members. The sample was based on that used in the NSF=s biennial Survey of Doctorate Recipients (SDR), and from this, two cohorts B 1981-82 and 1987-88 biomedical Ph.D.s who were sampled in the first survey wave that occurred after receipt of their doctorate B were chosen.[23] Publication data were provided by the Institute for Scientific Information (ISI), based on its indexed journals in the sciences.[24] The outcomes focus on the publishing profiles of individuals after they completed their graduate training C namely, the period from 1981-95.

Publishing in Refereed Journals

Overall, the large majority of biomedical scientists published one or more articles after their Ph.D.. For the two cohorts, examined, an estimated 84 percent of 1981-82 doctorates and 77 percent of the 1987-88 cohort were authors or coauthors on at least one article published between the year following their doctorate and 1995. Small but significant differences in favor of NRSA predoctoral recipients, however, did occur. In the earlier cohort, 91 percent of former trainees and fellows authored or coauthored at least one article by 1995

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[22] Due to trade secrecy restrictions, publication measures may be less suitable for evaluating research career outcomes for those working in business and industry. However, this most likely depends on the field and nature of the firm or corporation. For example, Stephan and Levin (1992), found that the publishing profiles of industrially employed biochemists were very similar to those in academia; however, physiologists employed by business and industry were less productive than their academic counterparts.

[23] As noted in Appendix B, both respondents and nonrespondents were included. An examination of publication counts based on frequency of response did not reveal any major differences between nonrespondents and respondents.

[24] The description of this data base and the strategy used for assigning articles to individuals is summarized in Appendix B, along with the results of a small-scale study on the reliability of this strategy.

compared to 82 and 81 percent of Ph.D.s from NIH and non-NIH training institutions. Corresponding percentages for 1987-88 Ph.D.s were 83, 74, and 74 percent, respectively. These figures translate into consistent differences, regardless of cohort and comparison (i.e., the differences between NRSA recipients and their counterparts in both comparison groups were the same).

Because it is likely that most biomedical scientists, even those who pursue non-research careers after completing their degree, publish their dissertation research, looking at Aever publishing post-Ph.D.@ is not very informative. Figures 3.21a-b diagrams the percent of individuals who publish at least one article in a given year after their doctorate (e.g., one year after their Ph.D., two years after, etc.). Here it can be seen that at nearly every time point following degree receipt, larger percentages of NRSA predoctoral recipients authored one or more publications. Not surprisingly, given that publication of articles reporting one=s dissertation research is common and the lag from journal acceptance to appearance in print, the rates were virtually the same for all three groups 1-2 years after completing the degree. However, the performance of former NRSA trainees and fellows diverged somewhat from that of both comparison groups, particularly at the point of 6-7 years after the doctorate.[25] Furthermore, for the 1981-82 cohort, the disparity widened as the percent of NRSA recipients who published in a particular year remained stable but declined in each comparison group. At fourteen years post-Ph.D., these group differences were nearly exactly the same as at the seventh year. This suggests that the NRSA-supported Ph.D.s continued to be actively involved in research, contributing regularly to the scientific literature.

This interpretation is somewhat reinforced by the data on publication counts during the time period after degree completion. As shown in Figure 3.22, the average number of post-Ph.D. publications was significantly higher for NRSA predoctoral trainees and fellows than for those from the two comparison groups. This was particularly true for the 1981-82 cohort where the mean was 12.8 for NRSA predoctoral recipients as compared to 9.0 for those from non-NIH training institutions. For biomedical scientists who earned their degrees from the same departments as the trainees and fellows, the mean was 9.7 B a slightly smaller but none-theless noticeable difference. The same pattern of differences occurred in the later cohort, although their magnitude was reduced (see Figure 3.21b).[26]

Not only was the output of NRSA predoctoral recipients somewhat greater but there also was some indication that this work received more recognition from fellow scientists. As indexed by the average number of citations per publication, the NRSA study group exhibited the highest mean and median citation rates of the three groups (see Figure 3.22). Although their counterparts from the same departments also performed better than those from programs with no NRSA training grants, former NRSA trainees and fellows did significantly better than both groups. Furthermore, these disparities, unlike the results for publication counts, did not diminish as much in size for the more recent cohort despite the fact that they had less time to publish their research and have it cited by others.

[25]The differences between the NRSA study group and its two comparison groups was small in magnitude (the effects sizes were 0.24 and 0.31 for the 1981-82 cohort and 0.20 and 0.17 for the 1987-88 cohort) and statistically significant for both cohorts in year 7. No difference was found between the two comparison groups

[26]The medians for the NRSA study, NIH training institution, and non-NIH training institution groups in the 1981-82 cohort were 8.5, 5.0, and 4.0, respectively. Corresponding medians 1987-88 Ph.D.s were 4.0, 3.0, and 2.0.

Figure 3.21a
Percent of 1981-82 Biomedical Ph.D.s Who Published One or More Articles in a Given Year

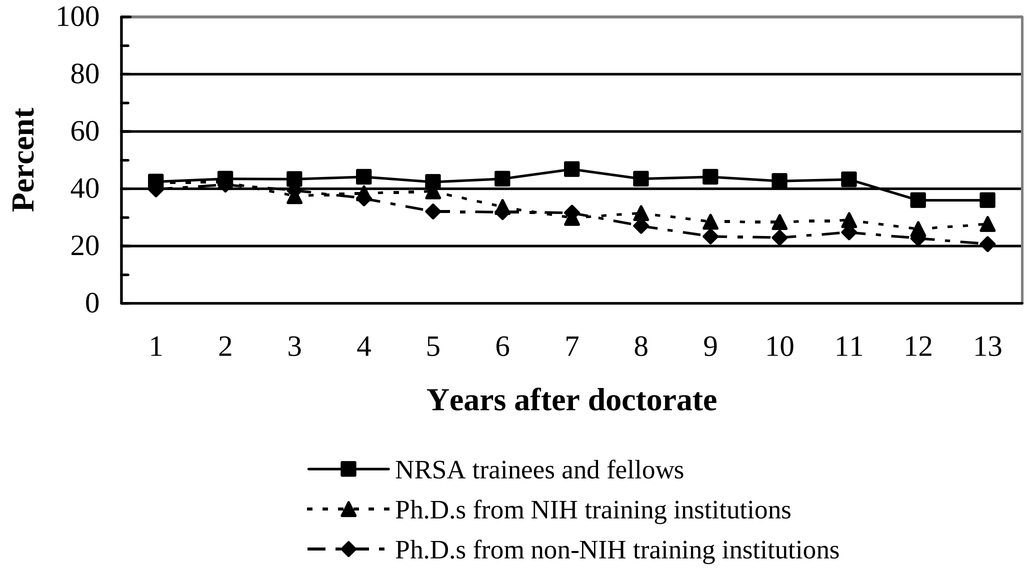
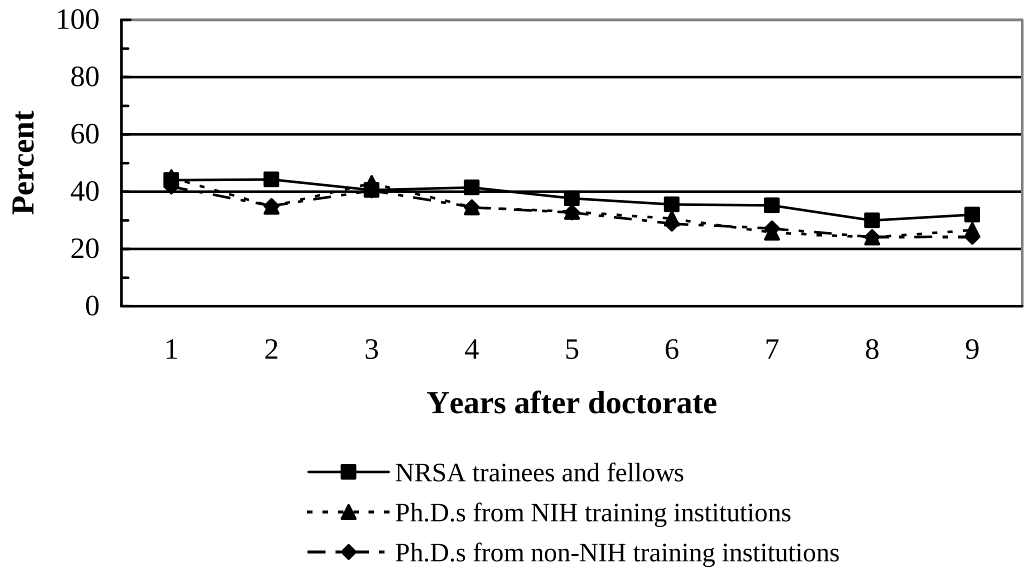


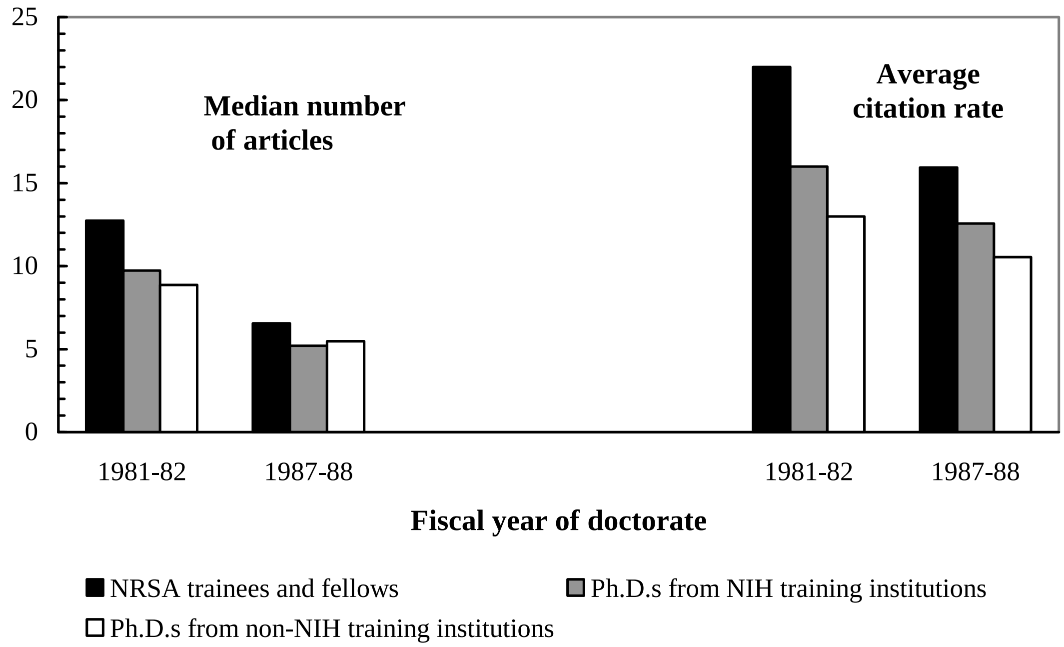
Figure 3.21b
Percent of 1987-88 Biomedical Ph.D.s Who Published One or More Articles in a Given Year



Note. Data are from the Institute for Scientific Information.

Figure 3.22

Median Number of Post-Ph.D. Published Articles and Average Citation Rates to these Articles for 1981-82 and 1987-88 Biomedical Ph.D.s by Group



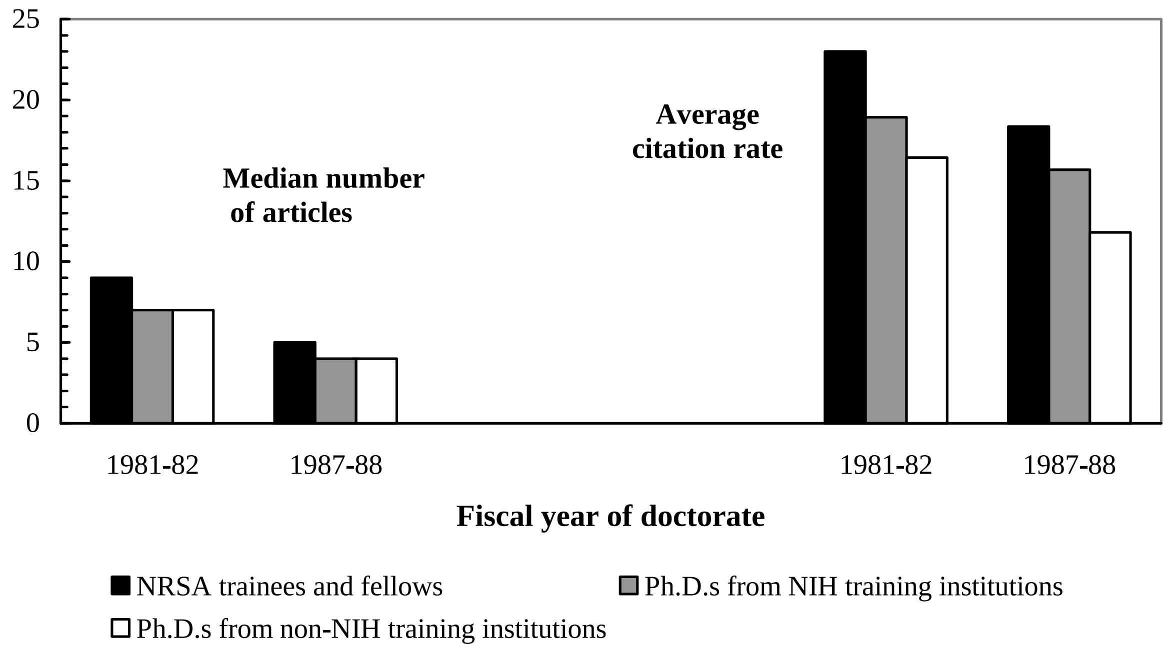
Note. Data are from the Institute for Scientific Information and cover the period from 1981 through 1995. See Appendix Table D.22 for information on group differences.

While encouraging as to the potential value of NRSA predoctoral training in facilitating productive research careers, other factors may be responsible for (or at least contribute to) the greater output of the NRSA study group. Certainly, additional postdoctoral training can exert an influence, although Coggeshall and Brown (1984) found that the NRSA-supported graduates still outshone those in the comparison groups in terms of both numbers of authored articles and the average number of citations per article after controlling for postdoctoral study. Another plausible explanation for the observed results, however, is field of degree. Because publishing profiles are typically field dependent, it is possible that the group differences in publication outcomes are a product of differences in disciplinary composition which was not identical for all groups (see Chapter 2). This was partially examined for those in one group of basic biomedical sciences where the sample size permitted further analysis B Ph.D.s in anatomy, biochemistry, biophysics, cell/developmental biology, endocrinology, genetics, immunology, microbiology/ bacteriology, molecular biology, neuroscience, and physiology. Because these are the same fields where postdoctoral training has become, for all practical purposes, a prerequisite, the results can also indirectly control for involvement in postdoctoral study.

Figure 3.23 compares the number of authored journal articles and citation rates for these articles for individuals in these disciplines by cohort and group. In terms of publication counts, the higher publication counts for former NRSA trainees and fellows only characterized the earlier cohort, with the differences between study and comparison group members disappearing for 1987-88 Ph.D.s. The pattern was quite differ-

Figure 3.23

Median Number of Post-Ph.D. Published Articles and Average Citation Rates to these Articles for 1981-82 and 1987-88 Biomedical Ph.D.s in the Basic Biomedical Science Disciplines



Note. Data are from the Institute for Scientific Information and cover the period from 1981 through 1995. See Appendix Table D.23.

ent, however, in terms of average citations per publication. Here, the differences between NRSA-supported Ph.D.s and those graduating from non-NIH training institutions persisted, although the size of these disparities narrowed. This is not the case for the 1987-88 cohort where the differences are nearly identical to those observed for all doctorates. This implies that even in the first seven years following Ph.D. receipt, NRSA fellows and trainees in the basic biomedical sciences produced research that was more recognized by other biomedical investigators as compared to their disciplinary colleagues who did not receive NRSA predoctoral support. Because most Ph.D.s in these fields pursued additional postdoctoral training, the enhanced publication and citation rates for the NRSA group cannot be solely a product of the field and postdoctoral training differences between the study and comparison groups.

Factors Influencing Publication Counts and Citation Rates

Several factors contribute to publication patterns such as age (Stephan & Levin, 1992), gender (e.g., Long, 1992; Sonnert & Holton, 1995), prestige of doctoral institution (e.g., Coggeshall & Brown, 1984), and postdoctoral training (Garrison & Brown, 1986). To explore the roles of these and other variables to the observed group differences, multiple regressions were conducted on post-Ph.D. publication counts and citation rates for respondents to the 1995 SDR.[27]

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[27] Analyses on these outcomes were on the logarithmic transformations of publication and citation counts, given the skewed natures of the distributions. Because respondents to the 1995 SDR were more likely to have published than

Looking at the comparisons involving the NRSA and either comparison group, it was found that having had postdoctoral training was again strongly related to publishing more articles, all else being equal (see Appendix Table D.24). This was true for both NRSA-supported postdoctoral study and that supported by other sponsors. In addition, having had a tenure-line position in an academic setting B an environment that strongly reinforces publication of research B also helped to predict the number of publications by 1995. Similar to previous studies on research productivity, women published fewer articles. After taking into consideration these factors, the role of NRSA predoctoral support did not contribute significantly to the observed group differences.

In terms of citation counts, the strongest predictor, as expected, was number of publications C authoring more articles resulted in more citations (see Appendix Table D.25). Consistent with previous research, graduating from a distinguished institution also was associated with greater numbers of citations as was earning one=s degree in a basic biomedical science discipline such as biochemistry, genetics, neuroscience, or pharmacology. This latter result may be associated with disciplinary differences in publication and citation patterns. While the type of postdoctoral training did not affect citations, all else being equal, the amount of time spent in postdoctoral training did predict higher citation rates. Controlling for these other variables reduced the role of NRSA predoctoral support to the point where it no longer helped explain a significant amount of the differences between groups.

Summary

Although limited to only two cohorts, the above findings suggest that NRSA predoctoral recipients remained actively engaged in biomedical research, contributing to its body of knowledge after completing their graduate study. They also had slightly stronger publishing records and higher citation rates than their comparison group counterparts. With regard to the number of journal articles authored or coauthored by 1995, former trainees and fellows outperformed both two comparison groups nearly equally. In terms of quality, the differences favoring NRSA recipients were somewhat larger when comparing them with Ph.D.s from departments without NIH training support.

The reasons for these differences can partly be traced to such factors as reputation of the doctorate-granting institution and pursuit of postdoctoral study B characteristics which were significantly more common for former trainees and fellows and for which the contribution of NRSA support was identified. Once these outcomes and other variables had been taken into account, the analyses found that NRSA predoctoral support did not noticeably predict differences in publication activity.

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the full sample, this may affect the size of the group differences.

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