NIH LRP EVALUATION

Extramural Loan Repayment Programs
Fiscal Years 2003-2007

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National Institutes of Health Loan Repayment Program Evaluation Working Group

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The National Institutes of Health (NIH) Extramural Loan Repayment Program (LRP) is a set of programs that have as a mandate to attract and retain early career health professionals in biomedical and behavioral research careers. A barrier to entering these careers, particularly for physicians, is believed to be the educational debt burden from student loans. The LRP offers qualified applicants repayment of up to $35,000 per year of eligible educational debt in exchange for a 2-year commitment to conduct qualified research. Awardees may apply for additional one- or two-year renewal contracts.

The extramural NIH Loan Repayment Program is managed by the NIH Office of the Director, Office of Extramural Research, Office of Extramural Programs, Division of Loan Repayment. Since its inception in 2001, NIH has made approximately 7,500 awards totaling more than $347 million in loan repayment funds.

To determine whether the extramural programs are meeting their programmatic goals, DLR carried out a quantitative program evaluation for new extramural LRP applicants from FY2003 to FY2007. The evaluation addressed three key areas:
  (1) Are the extramural LRPs attracting early-career clinician researchers with high debt?
  (2) Do the LRPs positively affect career outcomes for awardees?
  (3) How do the LRPs compare to other NIH career development award programs?

Findings

Who is Applying?

- The number of new applications has remained fairly constant at about 1900 per year since 2003. The Clinical Research and Pediatric Research LRPs attract and fund over 80% of new applicants. About 46% of applicants receive awards; the success rate decreased beginning in FY2004 as NIH began funding LRP renewal contracts.
- The LRPs attract more women than expected based on the demographics of recent PhD and MD classes. Near-equal numbers of men and women applicants have physician doctoral degrees; however, 2.5 times more women applicants have academic doctorates. There is no gender difference in success rate.
- The LRPs are attracting more African Americans or Blacks in comparison to the demographics of recent MD and PhD graduating classes. This is largely due to programs funded by the National Center on Minority Health and Health Disparities (NCMHD). There are no racial or ethnic differences in success rate.
- The LRPs are attracting biomedical researchers with high debt compared to recent MD and PhD graduating classes.

- The LRPs are attracting early career researchers: 72% of new applicants apply within 6 years of receiving their qualifying degree. Most academic doctorates apply within 1-3 years of receiving their degree, while Physician Doctorates tend to apply near the completion of their residency, about 6 years after receiving their degree.

Do the LRPs Retain Participants?

- The LRPs are increasing the retention of physician doctorates in the NIH extramural workforce, both through increased grant applications and participation in research activities.
- The LRPs are selectively losing women awardees.
- At this point in the LRPs history, there is no significant difference between funded and non-funded applicants in research productivity. This may be because the current study examined outcome data for 1-4 years since award, which may be too soon a time point to use to measure productivity for LRP applicants. This may be further accentuated by the fact that LRP participants tend to be early in their career.

How does the LRP Compare to Other NIH Mentored Career Awards Programs?

- The LRPs are attracting applicants that are earlier in their research career than the K program. Overall, the top 10% of LRP awardees are more likely to be Academic Doctorates and to be within 3 years of degree than either K or LRP+K top 10% awardees.
- The K awardees were more likely to apply for NIH Research Project Grant (RPG) support 1-4 years after their award than the LRP awardees. This follows from the previous finding that the LRP awardees are in a less developed career stage than K awardees and may need time to produce research results that can support a RPG application.
- Gender distribution among the top 10% of awardees was similar for LRP and K awardees. However, K awardee women were more likely than their LRP counterparts to apply for subsequent NIH grant support and to be retained in the NIH extramural workforce 1-4 years after award.
- Similarly, even though the LRPs have a clear retention effect on physician doctorates, K awardee Physician Doctorates were more likely to apply for and receive subsequent funding, and to be retained in the NIH extramural workforce 1-4 years after award.

Conclusions and Recommendations

- These findings suggest that the LRP is attaining its goals and may be a model program for recruiting and retaining early career scientists who otherwise would have a high tendency to leave the biomedical research workforce after earning a doctoral degree.
- The LRP appears to be effective in recruiting and retaining its target population, physician doctorates, but is not effective in retaining its largest applicant pool, women PhDs. It would be appropriate to examine program design and retention in more detail to determine how the LRP can better serve women PhDs.
- The LRP is attracting early-career researchers, who appear to be in an earlier stage of their career maturation than K awardees. The NIH may consider helping to prepare LRP awardees for

subsequent grant submissions, for example, to the K-awards process, to improve retention in the NIH extramural workforce.

- This evaluation focused on researchers 2-5 years after their receipt of the LRP award. While this provides an early indication of whether the program is meeting its goals, it will be important to reassess LRP awardee research productivity in subsequent studies.

HISTORY OF THE NIH EXTRAMURAL LRP

The National Institutes of Health (NIH) Extramural Loan Repayment Program (LRP) is a set of programs that have a mandate to attract and retain early career health professionals in biomedical and behavioral research careers. A barrier to entering these careers, particularly for physicians, is believed to be the high educational debt burden from student loans. The LRP encourages qualified applicants an opportunity pursue research careers b y repaying their eligible educational debt in exchange for a 2-year commitment to conduct qualified research.[1] Awardees may apply for additional one- or two-year renewal contracts.

NIH administers several intramural and extramural LRPs. The intramural LRPs have been offered since fiscal year 1989 and are available to NIH intramural researchers only. The extramural Clinical and Pediatric Loan Repayment Programs (LRP) were established by Congress in 2000.[2] The extramural Clinical Research LRP for Individuals from Disadvantaged Background and the LRP for Health Disparities Research were established under the Minority Health and Health Disparities Research and Education Act of 2000 (Public Law 106-525).[3] The extramural Loan Repayment Program for Contraception and Infertility Researchers awards are made pursuant to the NIH Revitalization Act of 1993 (Pub. L. 103-43), adding section 487B of the Public Health Service (PHS) Act, Loan Repayment Program for Research with Respect to Contraception and Infertility, 42 U.S.C. 288-2.[4] The Lenfant Committee set NIH policy and procedures for the extramural program.[5]

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[1] The LRP provides for the repayment of up to $35,000 of the principal and interest of the extant educational loans of such health professionals for each year of obligated service. Loan repayment benefits represent taxable income. Payments equal to 39 percent of total loan repayments are issued to the Internal Revenue Service on behalf of program participants to offset Federal tax liabilities incurred.

[2] The Loan Repayment Program for Clinical Researchers was authorized under the Clinical Research Enhancement Act of the Public Health Improvement Act of 2000 (PL 106-505). The NIH define clinical research as "patient-oriented research that is conducted with human subjects…, or …involving material of human origin for which an investigator or colleague directly interacts with human subjects…or epidemiologic or behavioral studies, outcomes research or health services research…". The Loan Repayment Program for Pediatric Research was established under the Children's Health Act (PL 106-310). The Act defines Pediatric Research as research that is "directly related to diseases, disorders, and other conditions in children".

[3] http://grants.nih.gov/grants/guide/notice-files/NOT-OD-08-089.html; http://grants.nih.gov/grants/guide/notice-files/NOT-OD-08-086.html

[4] http://grants.nih.gov/grants/guide/notice-files/NOT-OD-08-087.html

[5] See, e.g., http://www.nih.gov/icd/od/foia/icdirminutes/icdir013102.htm; http://deainfo.nci.nih.gov/ADVISORY/ncab/122_0602/mins11Jun02.pdf.

The extramural LRPs are administered by the NIH Office of Extramural Research (OER), Office of Extramural Programs, Division of Loan Repayment (DLR). Twenty-four NIH Institutes and Centers participate in the LRP; their program funding level was set by NIH in FY2003 using a formula basis related to the size of their clinical research portfolio. The five extramural programs are:

(1) The **Clinical Research LRP** supports individuals who are conducting patient-oriented research with human subjects or research on the causes and consequences of disease in human populations involving material of human origin (such as tissue specimens and cognitive phenomena) for which an investigator or colleague that requires direct interaction with human subjects in an outpatient or inpatient setting;

(2) The **Pediatric Research LRP** supports individuals who are conducting studies of diseases, disorders, and other conditions that affect children;

(3) The **Health Disparities Research LRP** aims to recruit and retain highly qualified health professionals to research careers in basic research, clinical research, or behavioral research directly related to health disparity populations and the medically underserved;

(4) The **Clinical Research LRP for Individuals from Disadvantaged Backgrounds** offers an opportunity in clinical research to individuals from a family with an annual income below low-income thresholds published by the U.S. Bureau of the Census;

(5) Finally, the objective of the **Contraception and Infertility Research LRP** is two-fold: to evaluate, treat or improve conditions which result in the failure of couples to either conceive or bear young, and to provide new or improved methods of preventing pregnancy.

To qualify, LRP applicants must be US citizens or permanent residents, their educational debt must be greater than 20 percent of their annual salary and compensation, they must have a qualifying doctoral degree (except for CIR), and they must be in a position to commit at least 50 percent time (at least 20 hours per week) to research in a qualifying area. An applicant's research must be funded by a domestic nonprofit or U.S. Government (federal, state, or local) entity, and the institution at which the applicant is engaged in research must provide assurance of research support through the end of the two-year contract. The actual loan repayment amount is determined by a formula that includes the awardee's educational debt level and annual income.

There is only one application receipt date per year, in early December. Applications are assigned to and reviewed by each participating NIH Institute or Center (IC). Each IC conducts peer review of the applications using a panel composed of extramural scientists. Review criteria emphasize the potential to become a contributing scientist in the area of the LRP. Standard NIH scoring (100 – 500) is used. However, this score is only one part of the funding priority.

The extramural Loan Repayment Program has made approximately 7,500 awards from over $347 million in loan repayment funds from FY2001 through FY2007. To determine whether the extramural programs are meeting their programmatic goals, in FY 2008 DLR carried out a quantitative program evaluation of new extramural LRP applicants that submitted an application to the LRP during the FY2003 through FY2007 cycles.

EVALUATION OBJECTIVES

The overall objective of the LRP program evaluation is to determine whether LRP awards are effective in their broad purpose of recruiting and retaining early-career health professionals in biomedical and behavioral research careers. The evaluation addressed the following questions:

1. Who is applying to the extramural Loan Repayment Programs? Is the program attracting the target applicant pool of early-career researchers with high educational debt?
   a. How are applications distributed between the five programs?
   b. What is the racial, ethnic, and gender distribution of the applicant pool?
   c. What is the educational degree distribution of the applicant pool? How soon after earning their qualifying degree are researchers applying to the LRP?
   d. What is the educational debt level of LRP applicants?
   e. What proportion of LRP awardees are submitting renewal applications?

2. Does participation in the extramural Loan Repayment Program lead to increased retention in the extramural NIH-funded workforce?
   a. Are LRP award recipients more likely, less likely, or equally likely than matched non-recipients to apply for and receive subsequent NIH awards? To participate as a non-PI on a NIH research grant?
   b. Are there differences in retention by gender or degree?
   c. Are LRP award recipients more likely, less likely, or equally likely than non-recipients to publish research articles? How do the citation rates of the two groups compare?

3. How does the LRP compare to other NIH mentored career-development programs for early-career investigators?
   a. Are the applicant pools similar?
   b. Are retention and publication rates similar between NIH awards programs? Is there an effect of gender or degree on retention?

RESEARCH DESIGN

Scope. The extramural LRP initiated in fiscal year 2001 with the Health Disparities and Clinical Research LRP for Individuals from Disadvantaged Backgrounds LRPs. Then in 2002, NIH received the first applications for the Clinical and Pediatric LRPs. In FY 2003, NIH started to receive and fund renewal LRP applications. Between 2003 and 2007, the extramural program received 9,820 new applications, of which 4,565 were awarded. 4,092 renewal applications were also submitted, of which 2,937 were awarded.[6] The evaluation focused on those years after the renewal program had been established.

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[6] Note that this evaluation collected application counts as of 3/31 and awards as of 10/1. This differs in some years from the LRP Data Book, which collected application counts on 1/31/2003, 12/31/2003, 3/23/2004, 12/1/2005, 3/31/2006, and 3/31/2007.

Data Sources. The LRP Online Application System (OAS) database was the primary data source used for LRP applicant information. OAS contains records of personal, demographic, institutional, educational, funding, loan, and research project information for all LRP applicants. This information is submitted by applicants and their colleagues via a web interface during the LRP application process. Other activities related to the submission, including eligibility verification, financial vetting, peer-review, and funding decisions are also recorded in this database. Data can be aggregated into fiscal years/cohorts, is independent of prior years, and represents a snapshot of the applications following funding decisions, after which no more activities are recorded/updated.

We used the NIH grants database, IMPAC II, to obtain data on current and subsequent NIH grant applications for LRP and career development awardees. We gathered information on publications from the National Library of Medicine MEDLINE database and information on citations from the Thomson-Reuters ISI Web of Science.

Statistics. We used a Chi-square 2x2 contingency table to assess difference between groups. The p-value was calculated using a Fischer's exact test.

Applicant Pool. To understand who is applying to the extramural LRP we used data from OAS to analyze the following parameters for new LRP applicants from FY2003 to FY2007: (i) total applications by year; (ii) applications by LRP; (iii) applications by funding NIH Institute or Center (IC); (iv) gender; (v) race and ethnicity (vi) degree type; (vii) years since qualifying degree; (viii) prior research support; and (ix) educational debt level.

Impact of Participation. We used applicant data from OAS and priority score data from IMPAC II to develop matched cohorts of funded and not funded applicants. The cohort for this analysis was defined as unique new LRP applicants from FY2003 to FY2007. Using novel methodology (detailed in Appendix 3), we identified applicants and awardees on the "funding bubble" – the part of the distribution where applicants have an equal chance of being funded or not funded. We used a regression discontinuity design to examine the impact of receiving an LRP on subsequent involvement in the extramural NIH-funded workforce for funded and not funded LRP applicants. We used grant data from IMPAC II and Key Personnel data from the IMPAC II Enumeration table to determine subsequent Research Project Grant (RPG) and Fellowship and Training Grant application and awards for all applicants in the bubble. We determined if outcomes for participants varied by gender or degree. We also used a manually-verified automated process to match publications to applicant publications to determine whether productivity differed between the funded and not funded applicants.

Comparison with Other NIH Mentored Career Awards. We used LRP applicant data from OAS and grant data from IMPAC II to select the top 10% of awardees by priority score for LRP as well as the top 10% of mentored K awards, namely K01, K08, and K23 awards. We then performed the same grant outcome and publication productivity analyses as was conducted for the funding bubble group.

QUESTION 1 : WHO IS APPLYING?

1.1 Goals

Investigate the characteristics of the extramural applicant pool to understand who is applying to the program and whether the programs are attracting their target audience of early-career clinical researchers.

1.2 Methods

We defined a set of nine parameters to evaluate the applicant and awardee pool of the program. The parameters examined were: (i) total applications by year; (ii) applications by LRP; (iii) applications by funding NIH Institute or Center (IC); (iv) gender; (v) race and ethnicity (vi) degree type; (vii) years since qualifying degree; (viii) prior research support; and (ix) educational debt level. Single parameter analysis provided valuable information regarding the applicant pool, for example, the number of male and female applicants over the five-year evaluation period. However, this analysis was limited in its ability to evaluate conditional dependencies, for example, the number of male and female applicants with a certain degree type. Thus, to better understand parameter co-dependencies, we performed cross-parameter analyses.

1.3 New Applicants

1.3.1 New applications and awards, by program and IC

From FY2003 to FY2007, LRP received a total of 9,820 new applications and made 4,565 new awards, a success rate of 46%. The Clinical Research LRP received the majority of new applications (57%). Additionally, 26% were submitted to the Pediatric Research LRP, 13% to the Health Disparities Research LRP, and 2% each to the Clinical Research LRP for Individuals from Disadvantaged Backgrounds LRP and to the Contraception and Infertility Research LRP (**Figure 1**). A similar distribution was observed for new awards made by each LRP. These data and the success rates for each LRP are presented in **Table 1**.
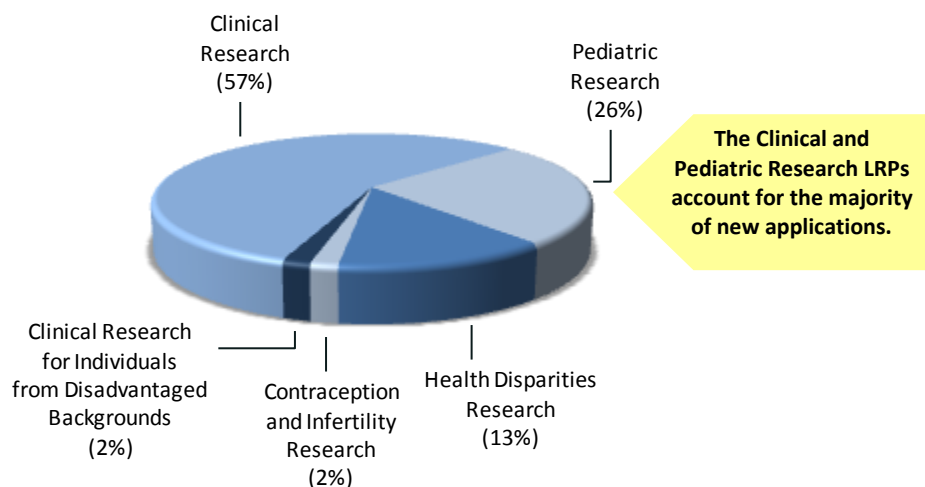
Figure 1. Distribution of new LRP applications, FY03-FY07.

Table 1. Number of new LRP applications and awards, FY03-FY07.

LRP	New Applications	Percent of New Applications	New Awards	Percent of New Awards	Success Rate
Clinical Research	5,646	57%	2,631	58%	47%
Pediatric Research	2,515	26%	1,102	24%	44%
Health Disparities Research	1,314	13%	674	15%	51%
Clinical Research for Individuals from Disadvantaged Backgrounds	171	2%	83	2%	49%
Contraception and Infertility Research	174	2%	75	2%	43%
Total	9,820		4,565		46%

The National Center on Minority Health and Health Disparities (NCMHD) receives all applications submitted to the Health Disparities Research LRP and the Clinical Research LRP for Individuals from Disadvantaged Backgrounds. All applications submitted to the Contraception and Infertility Research LRP are sent to the National Institute of Child Health and Human Development (NICHD). With the exception of NCMHD, the Clinical Research LRP and the Pediatric Research LRP are supported by all participating NIH ICs (**Table 2**).

Table 2. Supporting ICs for each LRP.

LRP	Supporting IC
Clinical Research	ICs except NCMHD
Pediatric Research	ICs except NCMHD
Health Disparities Research	NCMHD
Clinical Research for Individuals from Disadvantaged Backgrounds	NCMHD
Contraception and Infertility Research	NICHD

Of the total applications received between FY2003-FY2007, 15% of new applications were referred to NCMHD for review. The National Cancer Institute (NCI) received 13%, the National Heart, Lung, and Blood Institute (NHLBI) and the National Institute of Mental Health (NIMH) each received 11%, and NICHD received 10% of new applications. The complete distribution of new applications and awards for each IC is presented in Appendix 1.

1.3.2. New applications and awards, by gender

The National Science Foundation reports that in recent years, men received 52.5% of biological sciences Ph.D. degrees while women received 47.5%.[7] The American Association of Medical Colleges reports that 55.8% of M.D. degrees were earned by men and 44.2% by women.[8] Among biomedical postdoctoral researchers, 60.8% were male and 39.2% were female.[9]

To analyze gender distribution in the loan repayment program, we determined the number of men and women who applied for a new LRP award from FY2003 to FY2007. In contrast to what one may expect based on the potential pool of applicants among recent Ph.D. and M.D. graduates and postdoctorates, more new applications were submitted by women (53%) than men (44%).[10] This distribution and success rate is shown in **Figure 2**. The higher proportion of women LRP applicants is observed throughout the reporting period. The success rates for men and women are not significantly different.
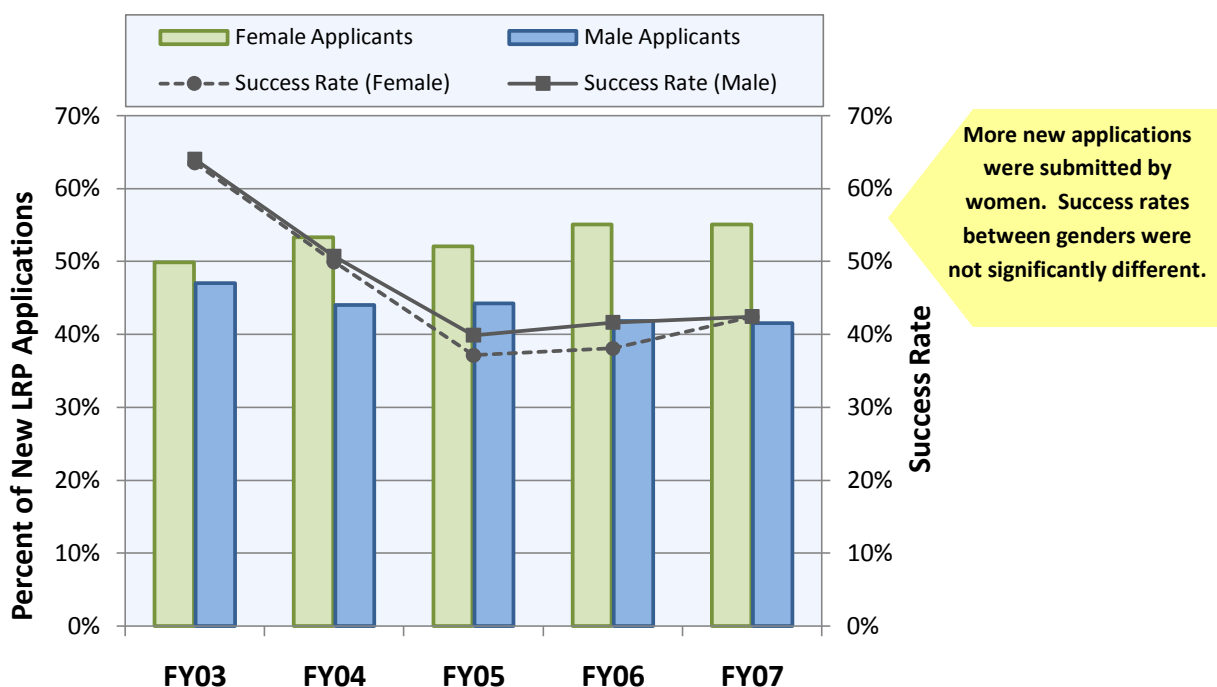
Figure 2. Gender distribution of new male and female LRP applicants, and success rates in each fiscal year, FY03-FY07.

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[7] National Science Foundation (2008). Women, Minorities, and Persons with Disabilities in Science and Engineering, Table F-11. National Science Foundation: Arlington, VA. http://www.nsf.gov/statistics/wmpd/figf-1.htm. We chose the 2001-2005 timeframe to calculate gender distribution as most PhDs apply for the LRP within one year of degree.

[8] Association for American Medical Colleges (2008). AAMC Data Book: Medical Schools and Teaching Hospitals by the Numbers, Table B10. AAMC: Washington DC. We chose the 1997-2001 timeframe as most MDs apply for the LRP 4-6 years after degree.

[9] National Science Foundation (2008). Women, Minorities, and Persons with Disabilities in Science and Engineering, Table G-2. National Science Foundation: Arlington, VA. http://www.nsf.gov/statistics/wmpd/postdoc.htm. We calculated the average gender distribution from 2001-2005.

[10] 3% of applicants did not specify gender.

1.3.3. New applications and awards, by race and ethnicity

Race and ethnicity data are self-reported on the LRP application form. The 1997 Office of Management and Budget (OMB) Directive 15 classifies race and ethnicity separately. This standard includes collecting and reporting data on two ethnic categories (Hispanic or Latino[11], and Not Hispanic or Latino) and five racial categories (American Indian or Alaska Native[12], Asian[13], Black or African American[14], Native Hawaiian or Other Pacific Islander[15], and White[16]). Until FY 2008, the application form did not separate the ethnicity designation from the race designation; however applicants were allowed to select one or more, thus allowing them to select ethnicity and race. Analysis of race and ethnicity for this report is in accordance with OMB Directive 15, as described below.

The National Science Foundation reports that Hispanics received 4.5% of biological sciences Ph.D. degrees, Blacks 3.2%, Asians 12.7%, Native Americans 0.3%, and Whites 76%.[17] The American Association of Medical Colleges reports that 6.4% of M.D. degrees were earned by Hispanics, 7.1% by Blacks, 19.8% by Asians, 0.8% by Native Americans, and 64.1% by Whites.[18] Detailed data on the race/ethnicity of postdoctoral researchers are not readily available.

1.3.3.1 Distribution of ethnicity

From FY2003-FY2007, the number of new LRP applicants who self-identified as Hispanic or Latino during each fiscal year is shown in **Figure 3.** Between 5-7% of new LRP applicants identified themselves as belonging to this ethnic category; similar proportions were observed for new awardees as well (5-8%). The success rate is not significantly different from the overall applicant pool.

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[11] Hispanic or Latino: A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.

[12] American Indian or Alaska Native: A person having origins in any of the original peoples of North, Central, or South America, and who maintains tribal affiliations or community attachment.

[13] Asian: A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

[14] Black or African American: A person having origins in any of the black racial groups of Africa.

[15] Native Hawaiian or Other Pacific Islander: A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

[16] White: A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

[17] National Science Foundation (2008). Women, Minorities, and Persons with Disabilities in Science and Engineering, Table F-11. National Science Foundation: Arlington, VA. http://www.nsf.gov/statistics/wmpd/figf-1.htm. We chose the 2001-2005 timeframe to calculate gender distribution as most PhDs apply for the LRP within one year of degree.

[18] Association for American Medical Colleges (2008). AAMC Data Book: Medical Schools and Teaching Hospitals by the Numbers, Table B8. AAMC: Washington DC. We chose the 1997-2001 timeframe as most MDs apply for the LRP 4-6 years after degree.
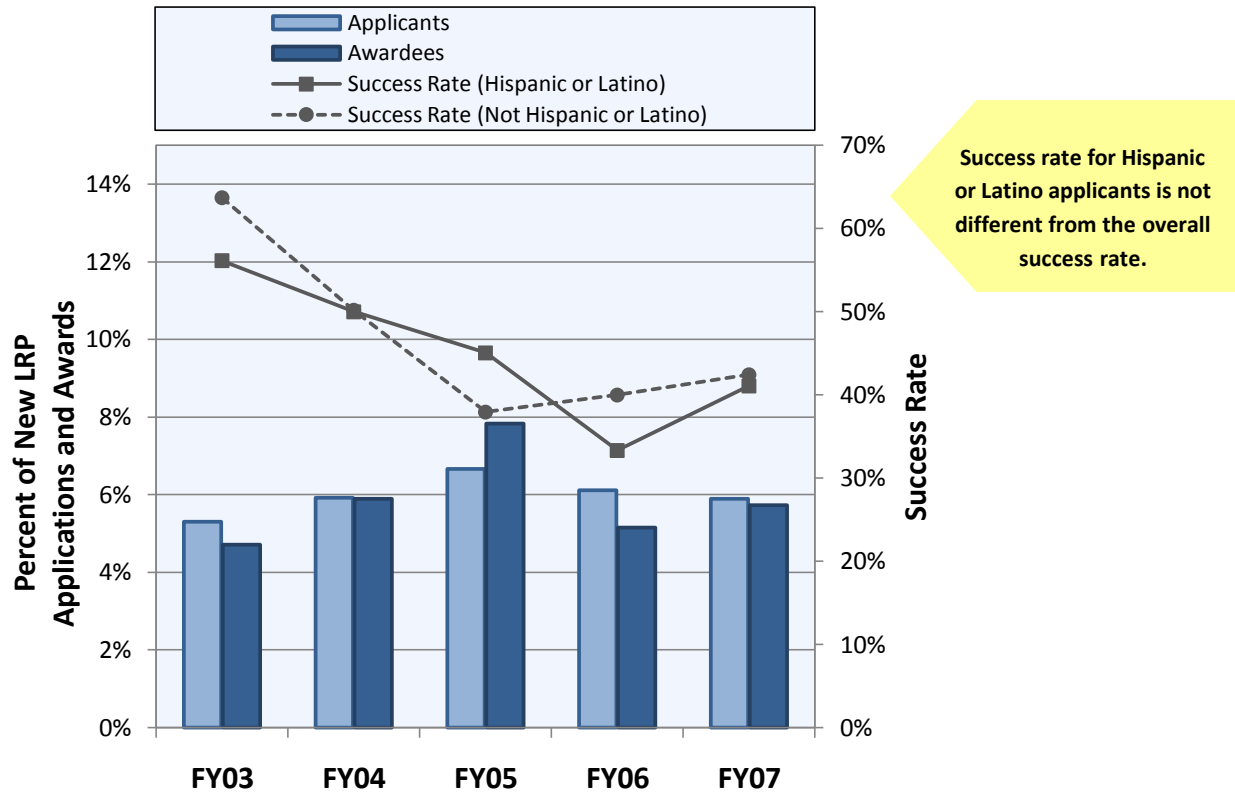
Figure 3. Percent of new extramural Hispanic or Latino LRP applicants and awardees in each fiscal year between FY03-FY07. Also shown is the success rate for the Hispanic or Latino and the Not Hispanic or Latino ethnic groups

1.3.3.2 Distribution of race

Data on race were analyzed by placing an applicant in one category only. Applicants who self-identified themselves in more than one category were assigned to a distinct multi-racial category. Those applicants who declined to respond to the question were classified in another distinct category, "Other/No Response". The distribution of race of applicants is shown in **Figure 4**.
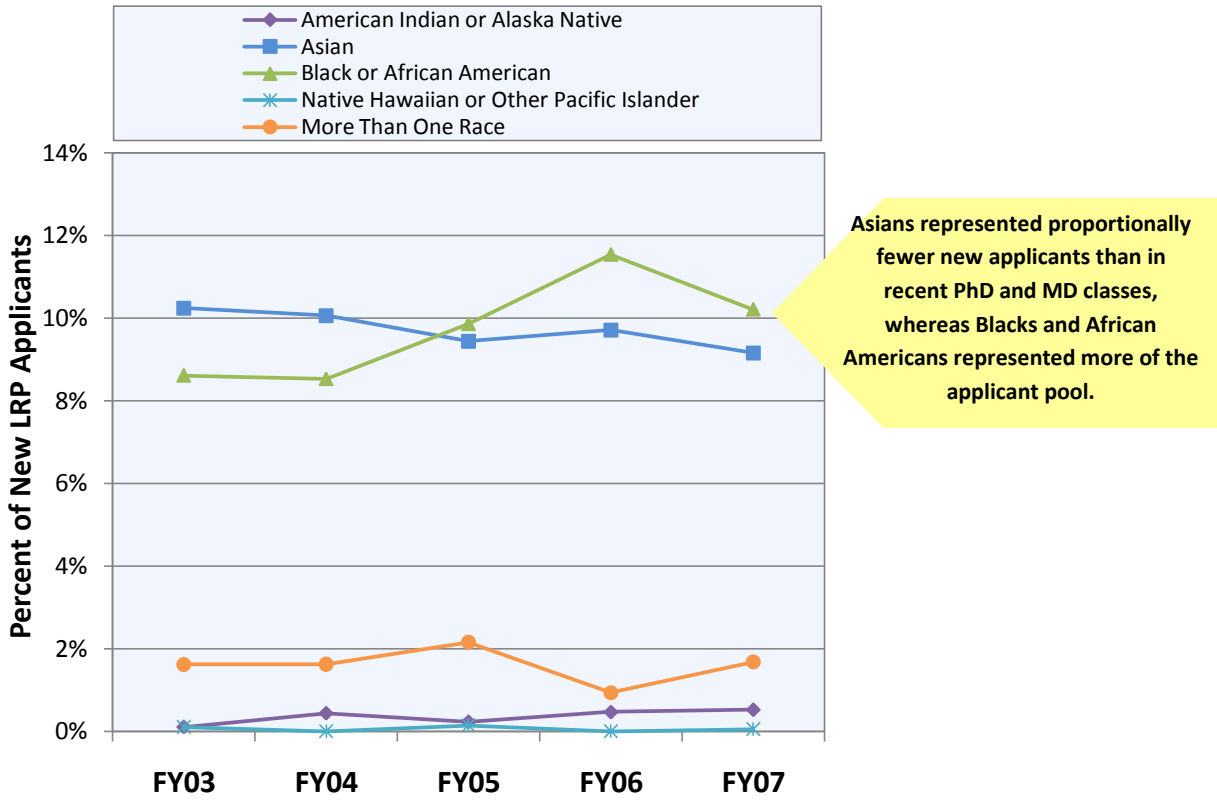
Figure 4. Percent of new extramural LRP applicants in the shown racial categories in each fiscal year from FY03-FY07.[19]

Asians represented ~10% of new applicants in each fiscal year between FY2003-FY2007, proportionately less than in recent PhD and MD classes. Blacks or African Americans represented between 9-12% of the new applicant pool during this reporting period, more than in recent MD and PhD classes. American Indians or Native Alaskans represented <1% of the new LRP applicants, as did Native Hawaiians or Other Pacific Islanders (<1%). Over the reporting period, Whites constituted an average of 64% of the new applicant pool, while multi-racial applicants comprised ~2% of applicants. On average, 9% of applicants declined to self-identify at the time of application to the LRP. The success rate for each racial category, shown in **Figure 5,** did not differ from each other or from the average overall success rate.

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[19] To avoid compression on the y-axis because of the difference between the proportion of White applicants and the other racial categories, this racial category is not represented in Figure 4. The distribution of Whites for each fiscal year is: 67% (FY03), 66% (FY04), 63% (FY05), 62% (FY06), and 63% (FY07).
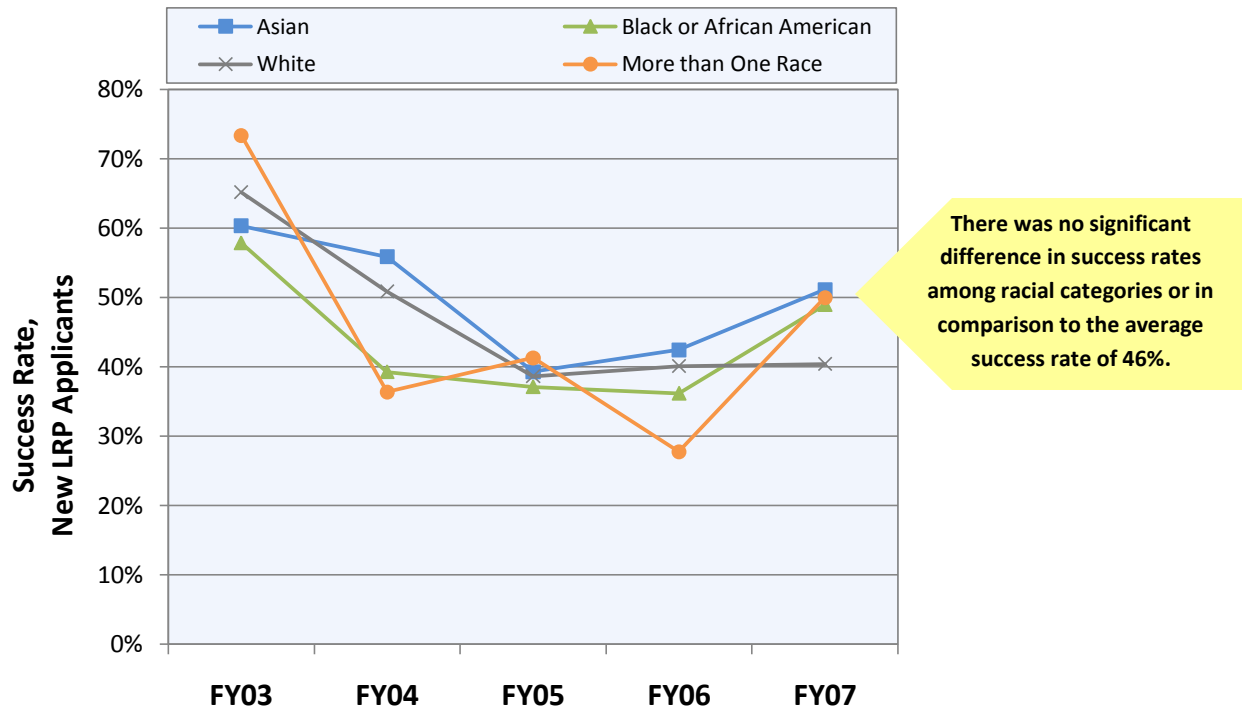
Figure 5. Success rates of new LRP applicants in the listed racial categories in each fiscal year, FY03-FY07. Due to the small sample size of the American Indian or Alaska Natives and the Native Hawaiian or Other Pacific Islanders, the success rate for these racial groups is not shown.

1.3.3.3 Distribution of ethnicity / race and gender

Figure 6 shows the distribution of ethnicity and race of new male and female applicants between FY2003-FY2007. For most categories, significantly more women applied than men.[20]

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[20] We were not able to measure significance for Hawaiian and Pacific Islanders due to small sample size.
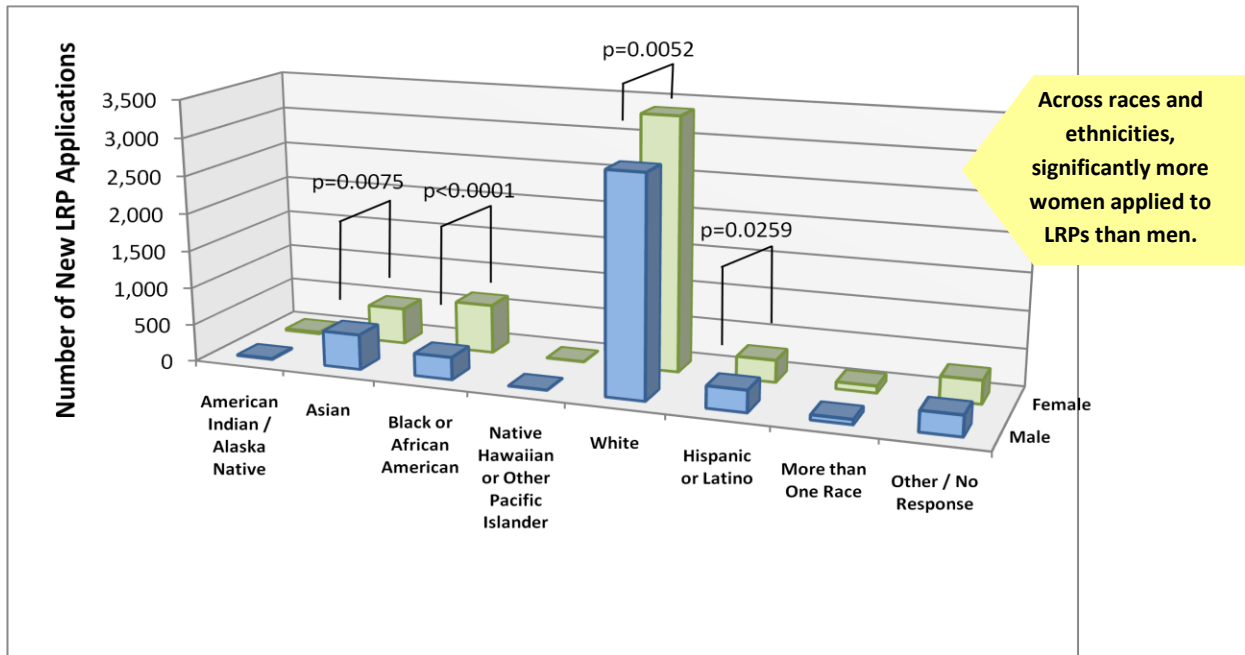
Figure 6. Gender distribution of ethnicity and race of new LRP applicants from FY03-FY07.

1.3.3.4 Distribution of ethnicity / race by IC

Figure 7 shows the distribution of ethnicity and race of new applicants by IC between FY2003-FY2007. The NCMHD LRPs account for the majority of applications by Blacks and Hispanics.
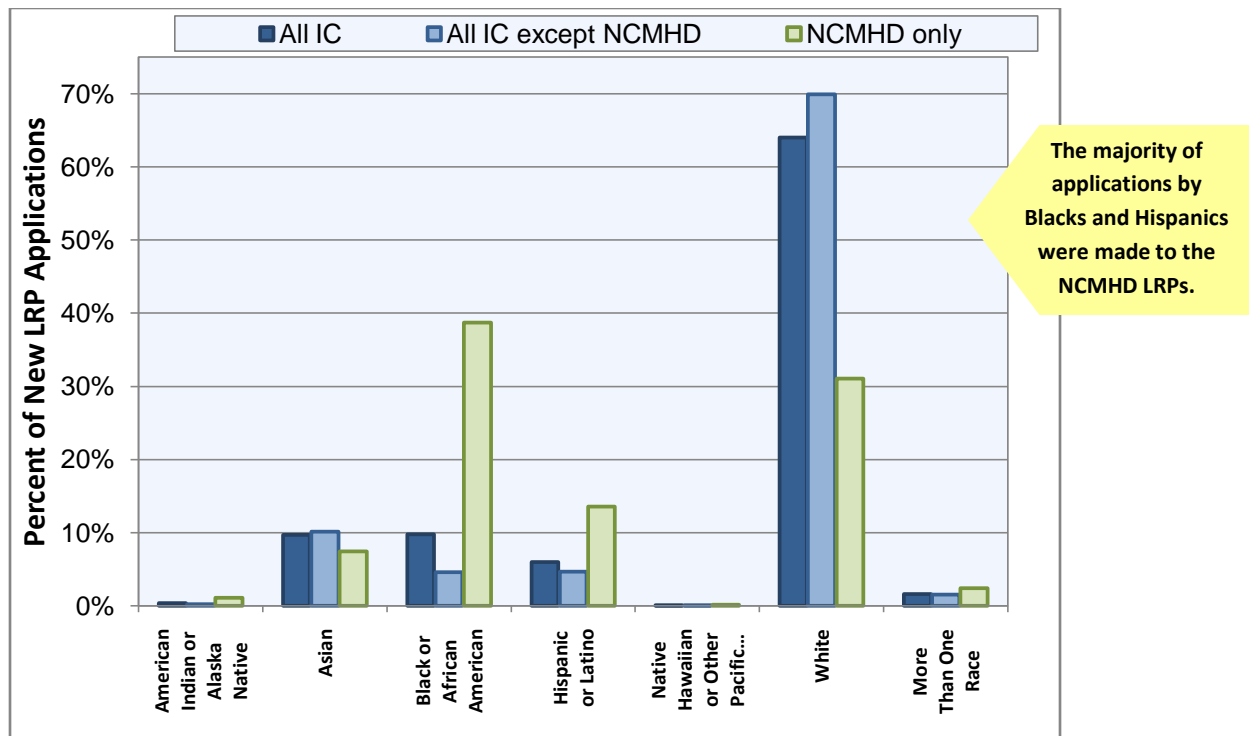
Figure 7. IC distribution of ethnicity and race of new LRP applicants from FY03-FY07.

1.3.4. New applications and awards, by degree type

To determine how successful the LRP has been in attracting early career health professionals in clinical research careers, we examined degree type and how long after earning a doctoral degree a person applied to the program.[21] Details about degree classification, including degree abbreviations, are included in Appendix 2.

1.3.4.1 Distribution of degree types

Table 3 shows the distribution of degree types for new applicants and awardees between FY2003-FY2007. Applicants with physician doctorates and with academic doctorates are represented at similar proportions (47% and 42%, respectively), with 6% of applicants having a dual physician doctorate/academic doctorate. Five percent of applicants had a professional clinical degree, while <1% were allied health professionals.

Table 3. Degree distribution of new LRP applicants and awardees, FY03-FY07.

Degree Type	New LRP Applications	% New LRP Applications	New LRP Awards	% New LRP Awards	Success Rate
Physician Doctorate	4,663	47%	2,134	47%	46%
Professional Clinical Doctorate	442	5%	135	3%	31%
Academic Doctorate	4,130	42%	1,915	42%	46%
Physician Doctorate / Academic Doctorate	551	6%	368	8%	67%
Allied Health Professional	34	<1%	13	<1%	38%
Total	9,820		4,565		

1.3.4.2 Distribution of degree types and gender

We examined the differences in the number of men and women applicants by gender and by degree. This cross-parameter analysis revealed gender differences, shown in **Figure 8**.

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[21] While a doctoral-level degree is a prerequisite for submitting an LRP application, the Contraception and Infertility Research LRP accepts applications from non-doctoral-level allied health professional degree holders, defined as those individuals with a bachelor's and/or master's degree in a relevant discipline.
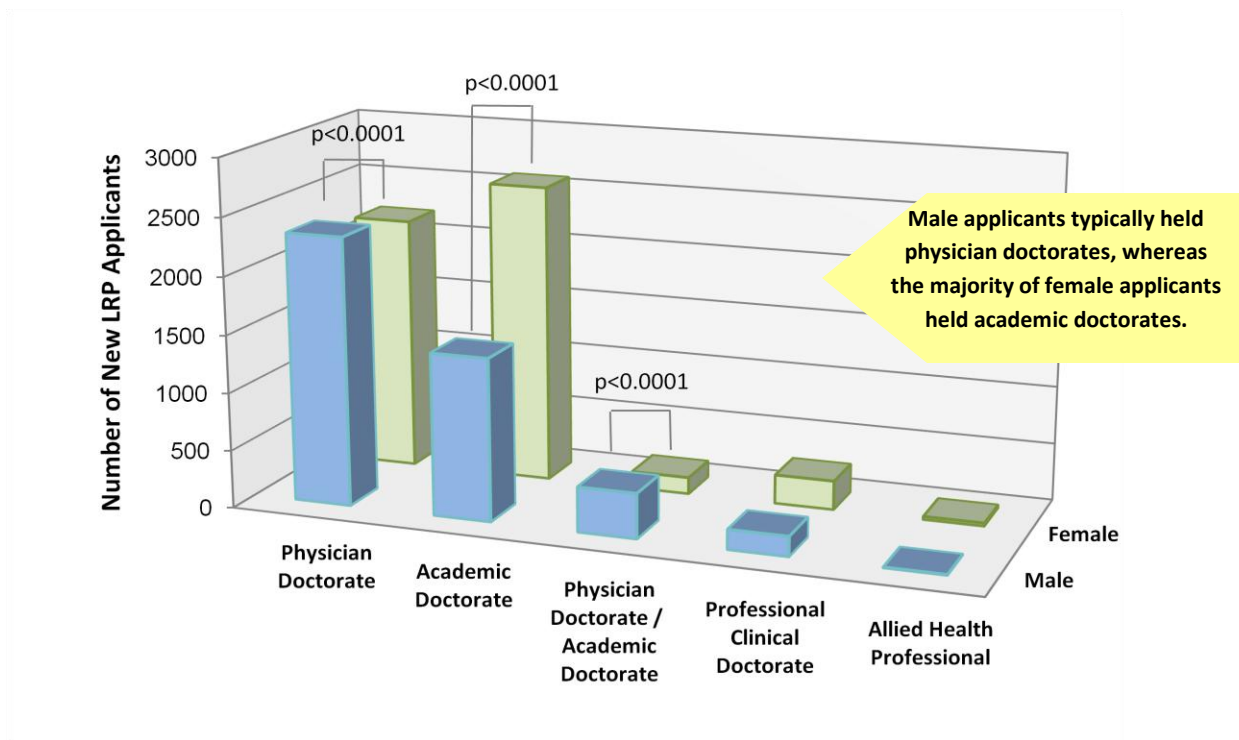
Figure 8. Gender distribution of new LRP applicants, by degree type, FY03-FY07

1.3.4.2.1 Degree by gender: Of all new male applicants (blue bars, **Figure 8**), a majority (54%) were physician doctorates and 33% were academic doctorates. In comparison, of all new women applicants (green bars, **Figure 8**), 42% were physician doctorates and 50% were academic doctorates.

1.3.4.2.2 Gender by degree: When comparing the distribution of men and women applicants across degree categories (i.e., comparing blue to green bars in **Figure 8**), there are significant gender differences in the proportion of applications from physician doctorates, academic doctorates, and dual physician doctorate/academic doctorates.

1.3.4.3 Distribution of degree types by IC

Another way to examine whether the LRP is reaching its intended audience is to test whether the applicant pool matches IC funding preferences. Of the 24 funding ICs, five have a publicly-stated preference for the type of doctoral degree an LRP applicant holds: the National Institute of Allergy and Infectious Diseases (NIAID), the National Institute of Biomedical Imaging and Bioengineering (NIBIB), NICHD, the National Institute of General Medical Sciences (NIGMS), and the National Institute of Neurological Disorders and Stroke (NINDS).[22] **Table 4** shows the distribution of degree types of the awardees at these ICs.

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[22] Based on the preference statements provided by each IC, posted on the LRP Web site at www.lrp.nih.gov.

Table 4. Proportion of new extramural LRP awards to physician researchers at ICs that state a funding preference for physician researchers, FY03-FY07.

IC	Percent of new LRP awards to physician doctorates, FY03-FY07
NIAID	77%
NIBIB	44%
NICHD	53%
NIGMS	79%
NINDS	72%

The other 19 participating ICs did not state a preference for applicant degree type. Details about the degrees of LRP recipients by IC are presented in **Appendix 1**.

1.3.5. New applications and awards, by LRP

1.3.5.1 Distribution of IC and LRP
The Clinical Research LRP and the Pediatric Research LRP were supported by all ICs except NCMHD, which does not participate in either program. Details about the participation of various ICs in the different LRPs are presented in Appendix 1.

1.3.5.2 Distribution of gender and LRP
To determine if there were any differences in the number of LRP applicants based on gender, a cross-parameter analysis was done of men and women applicants in each of the five LRPs, shown in **Figure 9**.
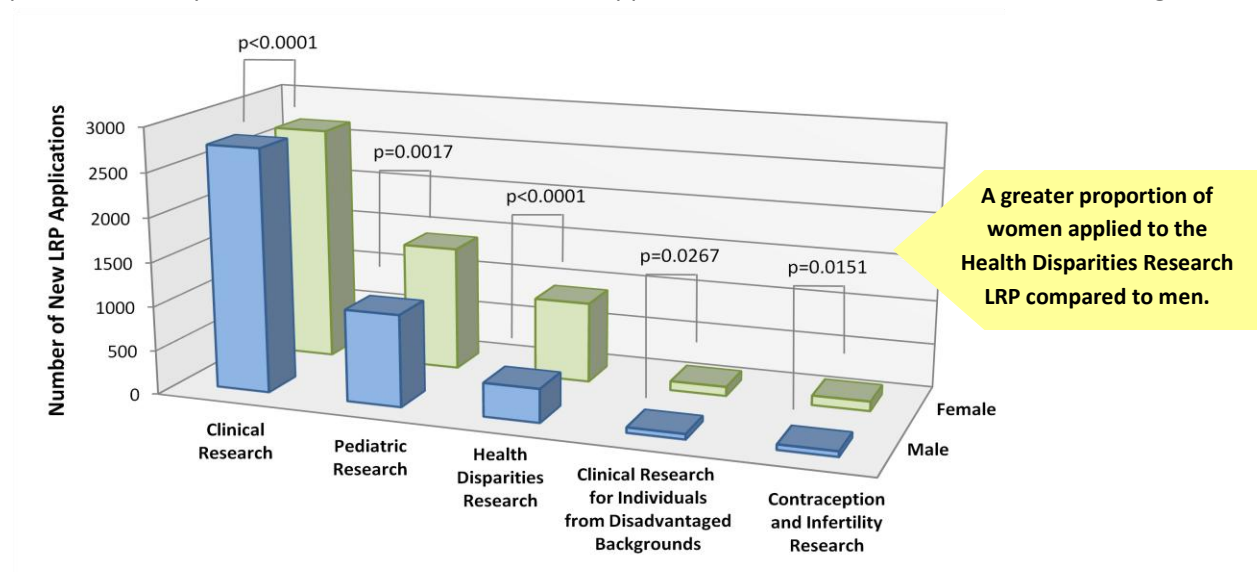
Figure 9. Gender distribution of new extramural applicants by LRP, FY03-FY07.

1.3.5.2.1 LRP by gender: Of all new male applicants, (blue bars, **Figure 9**), a majority (64%) applied to the Clinical Research LRP and 24% applied to the Pediatric Research LRP. This distribution was also seen among women applicants (green bars, **Figure 9**): a majority (51%) applied to the Clinical Research LRP and 27% applied to the Pediatric Research LRP. It is interesting to note that a greater proportion of women applications (17%, green bar) applied to the Health Disparities Research LRP than male applicants (9%, blue bar).

1.3.5.2.2 Gender by program: When comparing the distribution of men and women applicants in each of the five degree type categories (i.e., comparing blue vs. green bars in **Figure 9**), for all programs, there was a significant gender difference in the proportion of men and women applying. Proportionately more men applied to the Clinical Research program, and more women applied to the other four LRPs.

1.3.5.3 Distribution of degree types and LRP
We performed a cross-analysis of degree and LRP to determine what proportion of degree types submitted applications to each of the LRPs. As expected by the preferences of each IC and the differential representation of IC per LRP, the five degree types are not equally represented in each of the LRPs (**Figure 10**). This parameter set interrelates with the differential gender representation in the various programs: one would expect and we in fact did see more women in programs that have more academic doctorates. *Health Disparities Research* was the only LRP that attracted many more academic doctorates than physician doctorates: 74% of new applicants to this LRP were academic doctorates.
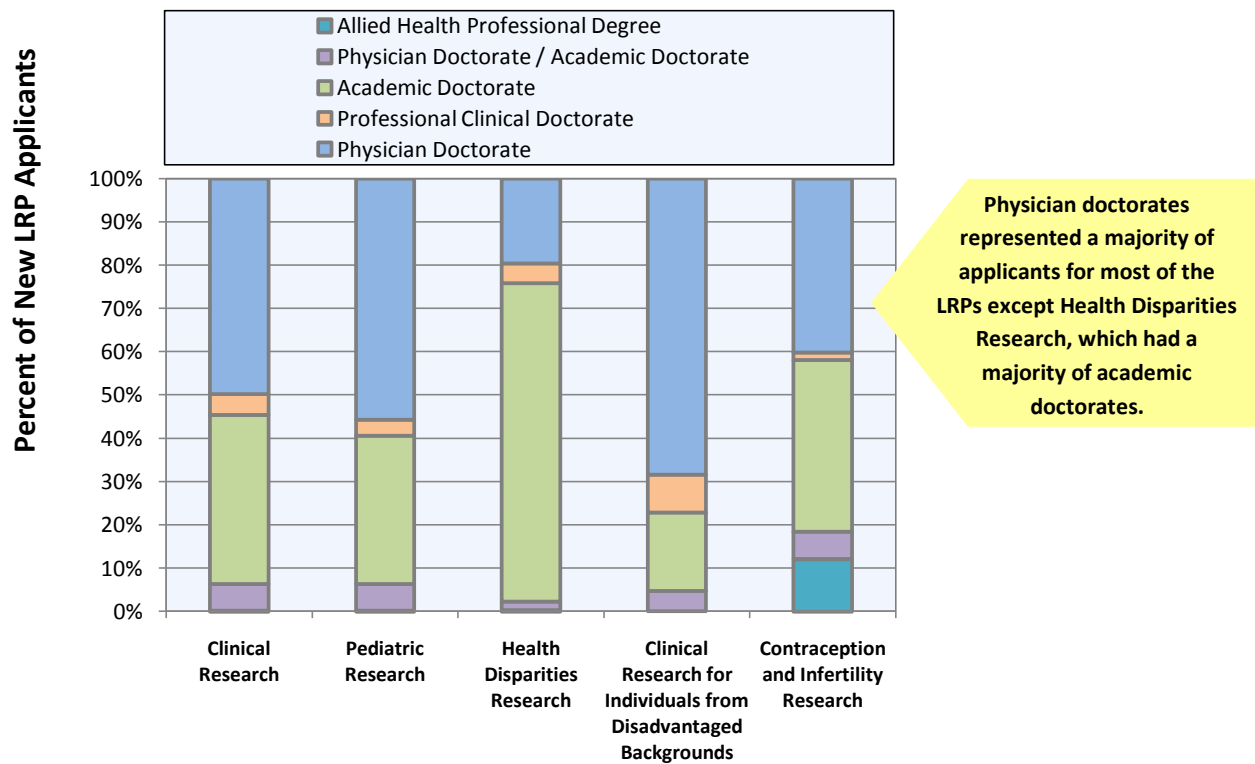
Figure 10. Distribution of degree type of new LRP applicants in each of the five LRPs, FY03-FY07.

1.3.6. New applications and awards, by years since degree

1.3.6.1 Distribution of years since degree and degree type

To determine if the program is attracting early career researchers, we analyzed years since qualifying degree for new applicants for the entire reporting period (FY2003-FY2007). Time since degree is dependent on a number of factors, including postdoctoral training, medical residency and internship, and available research support and resources. **Figure 11** shows the distribution of number of applications and awards plotted against the years since receiving a qualifying degree. Seventy-two percent of new applicants apply within six years of receiving their degree. Ninety percent of new applicants apply within nine years of receiving their degree. Of those applicants who applied after 10 years of receiving their qualifying degree 58% were Physician Doctorates, 19% were Academic Doctorates, 18% were dual Physician Doctorates/Academic Doctorates, 56% were men, and 41% were women—a very different distribution than that of the overall applicant pool.
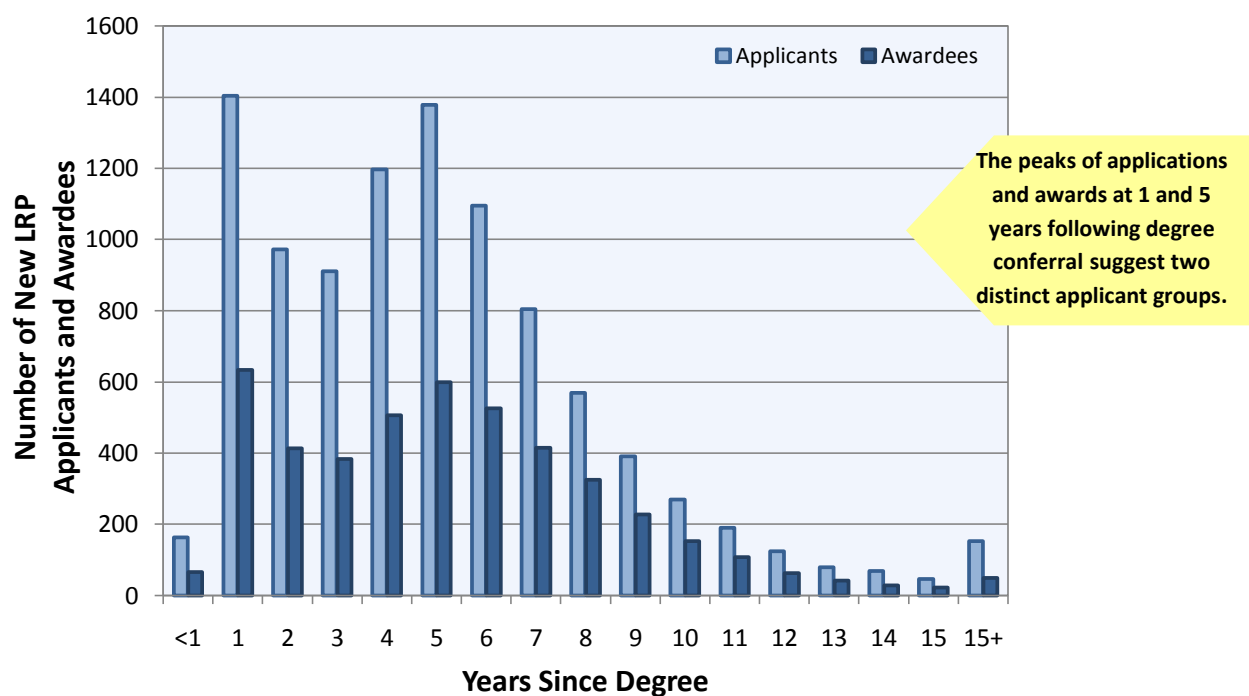
Figure 11. Distribution of years since degree of new LRP applicants, FY03-FY07.

The peaks observed at one and five years since degree suggest a bimodal distribution. To determine the underlying basis for this distribution, we performed a cross-parameter analysis with applicant degree type. As illustrated in **Figure 12A**, physician doctorates and academic doctorates apply to LRP at different times following their degree. A majority of academic doctorates (67%) apply within three years of receiving their qualifying degree, while only 9% of physician doctorates and 8% of dual degree physician doctorates/academic doctorates apply in the same time period. Conversely, 53% of physician doctorates (and 34% of dual doctorates) apply between four to six years of receiving their qualifying degree, and only 21% of academic doctorates submit applications at this time of their career (**Figure 12B**).
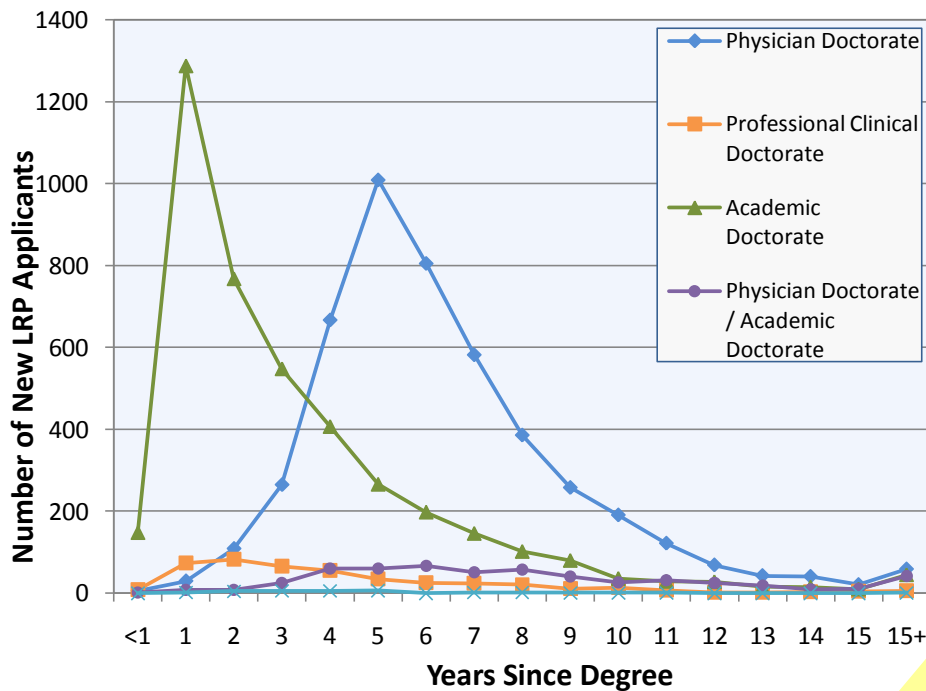
Most new LRP applications are filed within 3 years of degree conferral by academic doctorates and within 4-6 years by physician doctorates.
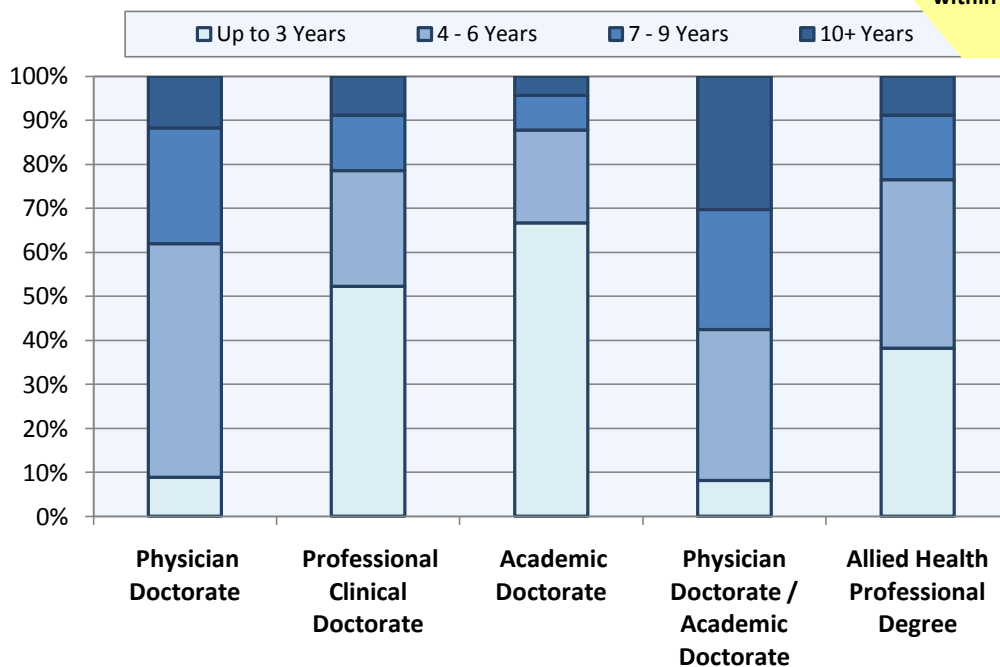
Figure 12. Years since degree distribution of new LRP applicants, FY03-FY07. A (top), Distribution of different degree types. B (bottom), Proportion of degree types with respect to time interval categories.

Based on this distribution, for cross-correlation analysis we defined four time intervals: (i) Up to 3 years; (ii) 4-6 years; (iii) 7-9 years; and (iv) 10+ years. Our analysis shows that a majority of new LRP applicants are in early stages of their career: 72% of applicants completed their qualifying degree within the six years prior to applying to the LRP, and 90% of new applicants completed their degree within nine years of applying to the program (**Figure 13**).

Up to 3 Years
(35%)

4-6 Years
(37%)

10+ Years
(10%)

7-9 Years
(18%)
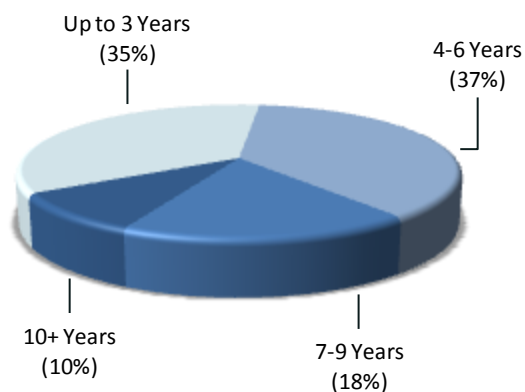
Figure 13. Interval distribution of years since degree of new LRP applicants, FY03-FY07.

1.3.6.2 Distribution of years since degree and gender

To determine if men and women applied to LRP at different times after completing their qualifying degree, we analyzed gender distribution in the four intervals defined above. More women (62%) apply for a new LRP award within three years of receiving their qualifying degree than men (35%) (**Figure 14**); this finding flows with the association between gender and degree. The proportion of new men and women applicants in other time intervals is relatively similar.

More women than men apply to LRPs within 3 years of receiving their degree
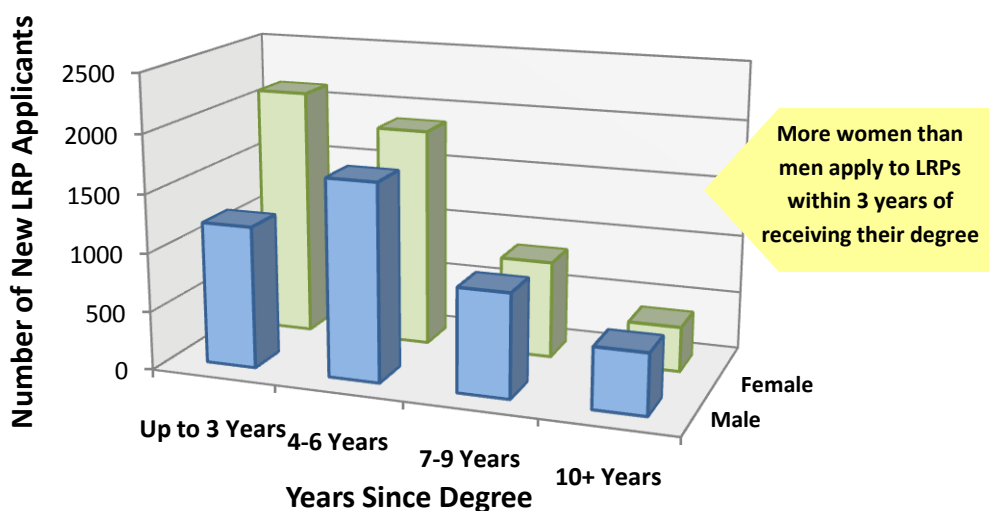
Figure 14. Gender by years since degree of new LRP applicants, FY03-FY07.

1.3.7. New applications and awards, by prior research support

For the new applicant and awardee pools, we analyzed the distribution of prior research support from three sources: the NIH alone, both NIH and non-profit organizations, and non-profit organizations alone. While a near-equal proportion of new applicants had prior research support from each of these three sources, 15% more awardees had prior research support from the NIH alone than from non-profit organizations alone (39% vs. 24%) (**Figure 15**). This observation extends to each fiscal year in the reporting period; individuals with prior research support from the NIH alone had a greater success rate than individuals with prior research support from non-profit organizations alone (**Figure 16**).

Although a comparable number had prior research support from either the NIH or non-profit organizations alone, new applicants with NIH funding were more likely to receive LRP awards.
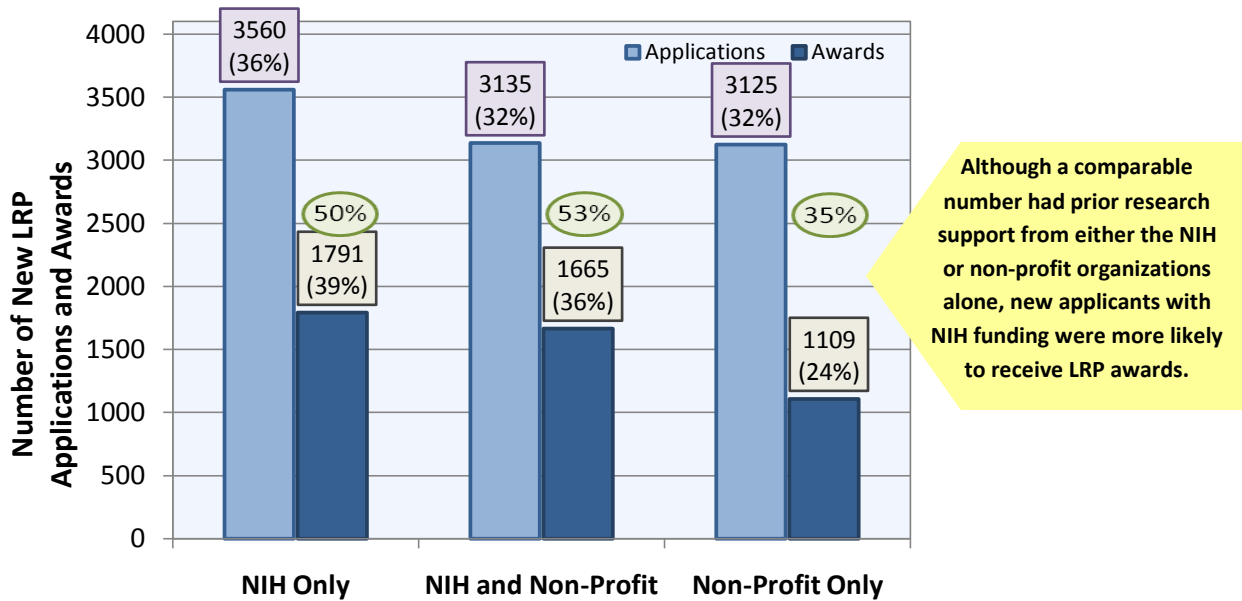
Figure 15. Prior research support of new extramural LRP applicants and awardees, FY03-FY07. The overall success rate of each group is shown (encircled numbers).
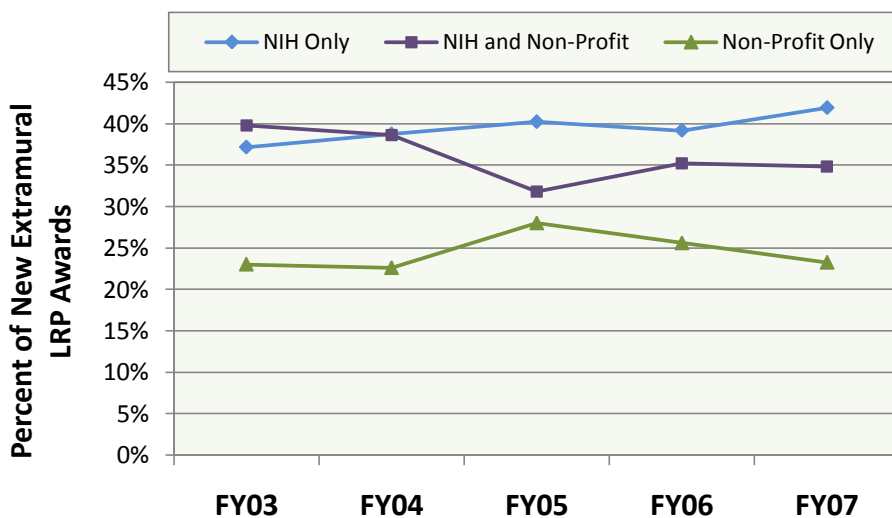
Figure 16. Percent of new extramural LRP awardees FY03-FY07 by prior support source.

1.3.8. New applications and awards, by educational debt level

The goal of the loan repayment programs is to attract healthcare professionals into research careers by offering qualified researchers an opportunity to pay down educational debt. The programs make payments on all qualified educational debt, provided that the educational debt is at least 20% of the applicant's annual base salary. New LRP applicants are required to report their current educational debt level as part of their application to the program. Prior to awards being made, the Division of Loan Repayment verifies the legitimacy of the loans and the current balances.

We compared reported debt for LRP applicants to that reported by NSF for the pool recent graduates. Among biological sciences academic doctorates, 50% reported no educational debt at the time of graduation. Of those with debt, 41% reported cumulative debt under $50,000. The average debt was about $20,000.[23] Among medical school graduates, 17.2% reported no debt, 14.2% reported debt under $50,000, and 28.8% reported debt under $100,000. The average debt upon graduation was $97,000.[24]

1.3.8.1 Distribution of educational debt level

Debt levels of a majority of non-awardees are usually not verified. We determined the correlation between reported and verified debt levels by comparing these amounts for a subset of applicants for which both sets of amounts were known, namely, the 4,565 new LRP awardees. As shown in **Figure 17**, these amounts correlate strongly, with an $R^2 = 0.907$ (**inset**, Figure 17). We therefore used applicant reported (but unverified) debt level for subsequent analysis.

> There is a strong correlation between reported and verified debt levels of new LRP applicants.
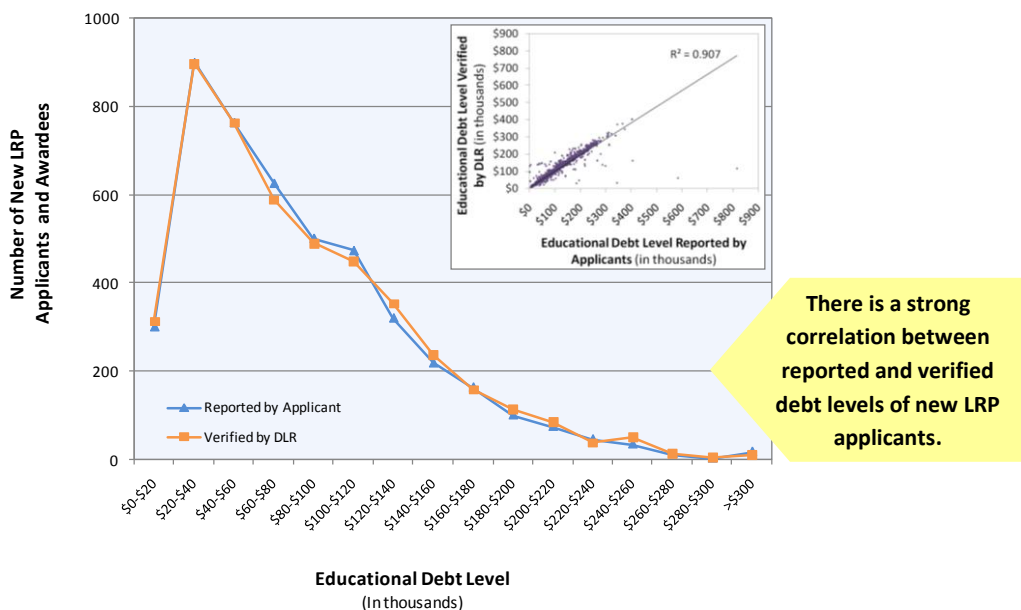
Figure 17. Correlation between applicant reported and DLR verified educational debt level of new LRP applicants, FY03-FY07.

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[23] National Science Foundation (2008). Science and Engineering Indicators, Appx. Table 2-12. NSF: Arlington, VA. Note that educational debt for psychology PhDs, who make up over 40% of the LRP applicants, is higher. 70% of psychology PhDs graduate with some debt (vs. 50% for biology), and 29% have < $50K in debt (vs. 8% for biology).
[24] Association of American Medical Colleges (2008). AAMC Data Book: Medical Schools and Teaching Hospitals by the Numbers, Table E4. AAMC: Washington, DC. We used student-reported responses from 2001.

We next analyzed the distribution of educational debt level of all 9,820 new LRP applicants (**Figure 18**). Sixty three percent reported an educational debt level up to $100,000; 31% reported an educational debt level between $100,000 and $200,000, and 6% reported an educational debt level greater than $200,000.

The majority of new LRP applicants reported an educational debt of up to $100,000.
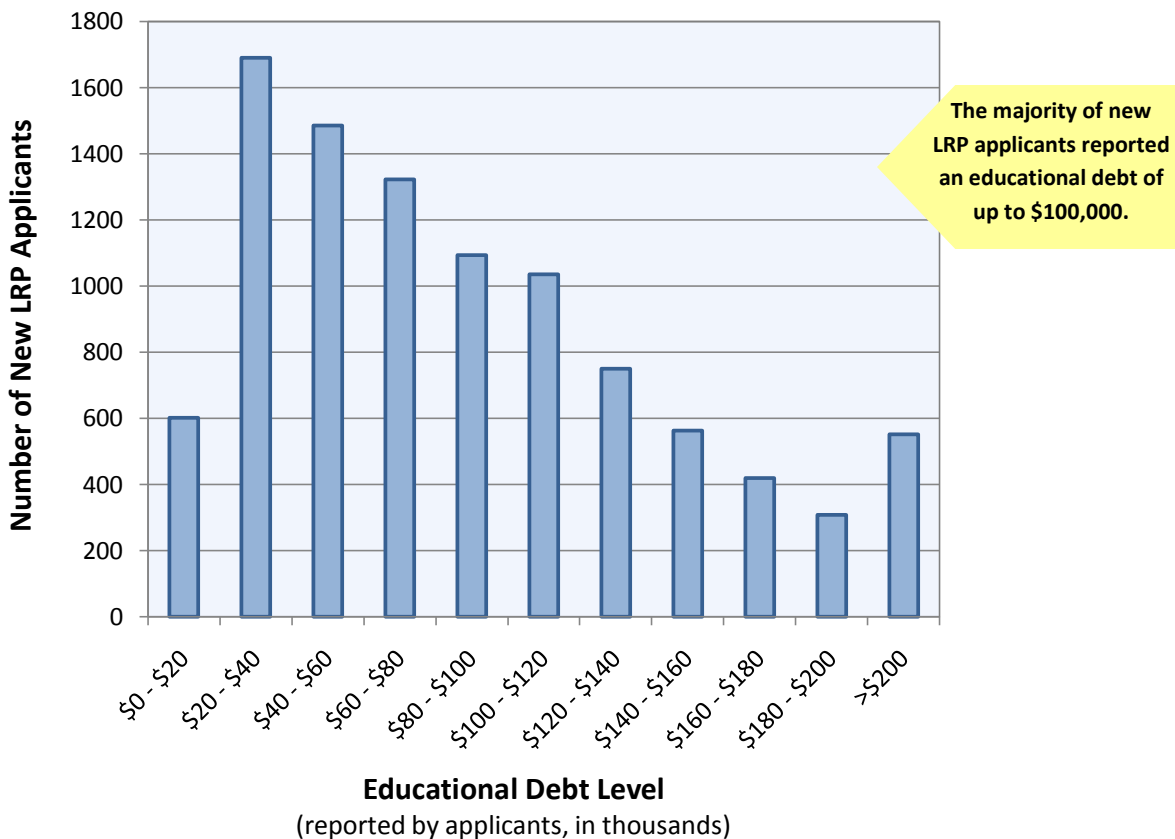
Figure 18. Reported educational debt level of new extramural LRP applicants, FY03-FY07.

1.3.8.2 Distribution of educational debt level and degree type

The distribution of debt level between applicants with different degree types shows striking differences (**Figure 19**). The proportion of academic doctorates in a debt range decreases with greater educational debt, with a corresponding increase in the proportion of physician doctorates. Seventy-nine percent of applicants with an educational debt less than $20,000 have academic doctoral degrees, while only 13% have physician doctorates. Similarly, of applicants with between $20,000 and $40,000 of educational debt, 66% have academic doctorates compared to 24% with physician doctorates. At higher educational debt levels ($180,000-$200,000), the difference is reversed and is even more striking: 83% of applicants with high debt have a physician doctorate while only 9% have an academic doctorate. The average debt reported by academic doctorates was $62,165 and by physician doctorates was $114,042, both substantially higher than the average debt of recent graduates (see above), an indicator that LRPs are attracting researchers with high debt.
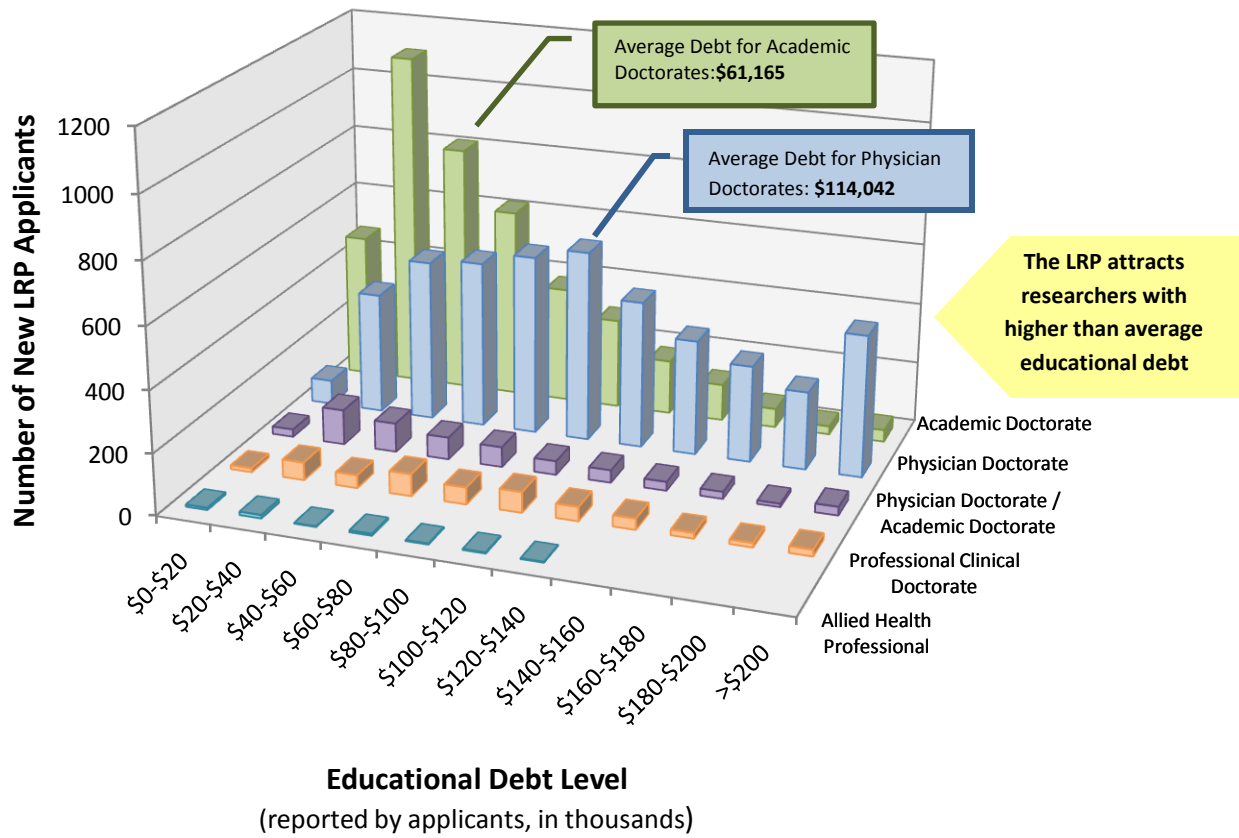
Figure 19. Distribution of reported educational debt level of new extramural LRP applicants with different degree types, FY03-FY07.

Summary of Findings
FY03 – FY07 Extramural LRP New Applicant Pool

New Applications to the Extramural LRPs

- Since 2003, there have been approximately 1,900 new applications per year to the extramural LRPs.
- Of the total applications in FY03-FY07, 15% were assigned to NCMHD, 13% were assigned to NCI, 11% were assigned to both NHLBI and NIMH, and 10% to NICHD.
- The Clinical Research and Pediatric Research LRPs received the majority of new applications.
- Overall success rate of new applications across the five LRPs is 46%.

Gender and Race and Ethnicity Identification of New Applicants

- More new applications were submitted by women (53%) than men (44%). There was not a significant difference in success rates between genders.
- More Blacks and fewer Asians applied in comparison to recent MD and PhD graduating classes. Success rates did not differ by race or ethnicity.
- The majority of applications by African Americans or Blacks and Hispanics were submitted to the NCMHD LRPs.

Educational Background of New Applicants

- The applicant pool was 47% physician doctorates and 42% academic doctorates.
- There are significant gender differences by degree type. Most male applicants (54%) held physician doctorates. In contrast, most female applicants (50%) held academic doctorates.
- Prior NIH research support increased an applicant's chance of receiving an LRP award.

Career Phase of New Applicants

- The LRPs attract early career researchers. 72% of new applicants apply within six years after receiving their degree, and 90% apply within nine years.
- Physician doctorates and academic doctorates apply to the LRPs at different stages of their careers. The majority of academic doctorates (67%) apply within 3 years of receiving their degree, while the majority of physician doctorates (53%) apply between 4-6 years of receiving their degree.
- More women applicants (62%) are within 3 years of receiving their qualifying degree than men (35%).

Debt Levels of New Applicants to the Extramural LRP

- Among new LRP applicants, the majority (63%) reported an educational debt less than $100,000, 31% reported a debt level between $100,000 and $200,000, and 6% reported a debt level greater than $200,000.
- Debt level differs with the degree type of the applicant. The majority of applicants in the debt ranges of $0-$20,000 and $20,000-$40,000 have academic doctoral degrees (79% and 66%, respectively). At the higher debt levels (over $100,000), the majority of applicants have physician doctoral degrees.
- Academic doctorates report an average debt of $62,165 compared to the average debt of $114,042 reported by physician doctorates.
- On average, LRP applicants have a higher debt load than recent MD and PhD graduates.

1.4. Renewal Applicants

LRP awardees are allowed to apply for one- or two-year renewals.   The same eligibility criteria for new applicants apply to renewal applicants with the exception of the 20% debt-to-income ratio. During the FY2003 through FY2007 application cycles, renewals comprised 29% of all LRP applications, and 39% of all awards. We asked three questions:

1. What is the historical trend of renewal LRP applicants and awardees from FY2003-FY2007?
2. Does degree correlate with the likelihood of applying for a renewal award?
3. Does educational debt level correlate with the likelihood of obtaining a renewal award?

1.4.1. Renewal applications and awards

From FY2003-FY2007, LRP received a total of 4,092 renewal applications and made 2,937 renewal awards, an overall success rate of 72%. Similar to new LRP applications, the Clinical Research LRP received a majority of renewal applications (58%). Twenty-four percent of applications were submitted to the Pediatric Research LRP, 14% to the Health Disparities LRP, 4% to the Clinical Research for Individuals from Disadvantaged Backgrounds LRP, and 1% to the Contraception and Infertility Research LRP. A similar distribution was observed for renewal awards made by each LRP (**Figure 20**). These data and the success rates for each LRP are tabulated in **Table 5**.

The majority of renewal applications are submitted to the Clinical Research and Pediatric Research LRPs.
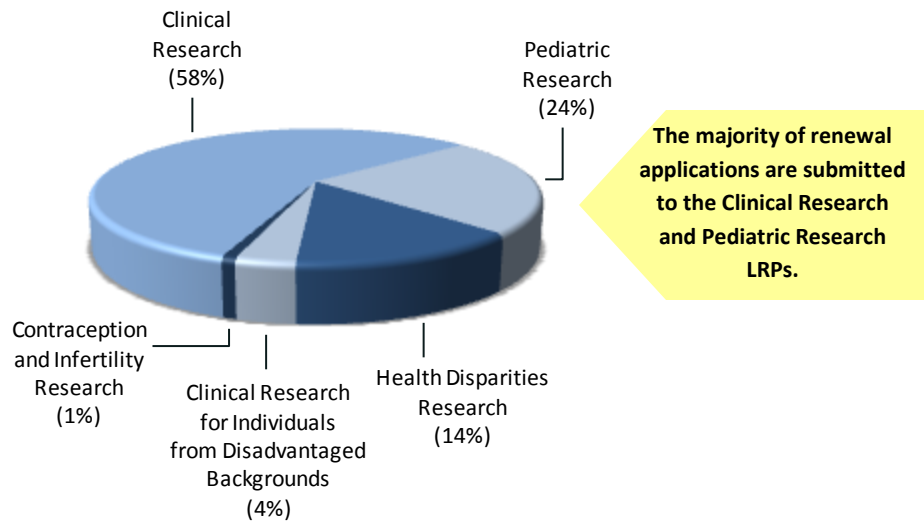
Figure 20. Distribution of renewal extramural LRP applications, FY03-FY07.

Table 5. Number of renewal extramural LRP applications and awards, FY03-FY07.

LRP	Renewal Applications	Percent of Renewal Applications	Renewal Awards	Percent of Renewal Awards	Success Rate
Clinical Research	2,379	58%	1,730	59%	73%
Clinical Research for Individuals from Disadvantaged Backgrounds	146	4%	106	4%	73%
Contraception and Infertility Research	34	1%	21	1%	62%
Health Disparities Research	569	14%	390	13%	69%
Pediatric Research	964	24%	690	23%	72%
Total	**4,092**		**2,937**		**72%**

The number of renewal applications received and renewal awards made in each fiscal year from FY2003-FY2007 is shown in **Figure 21**.
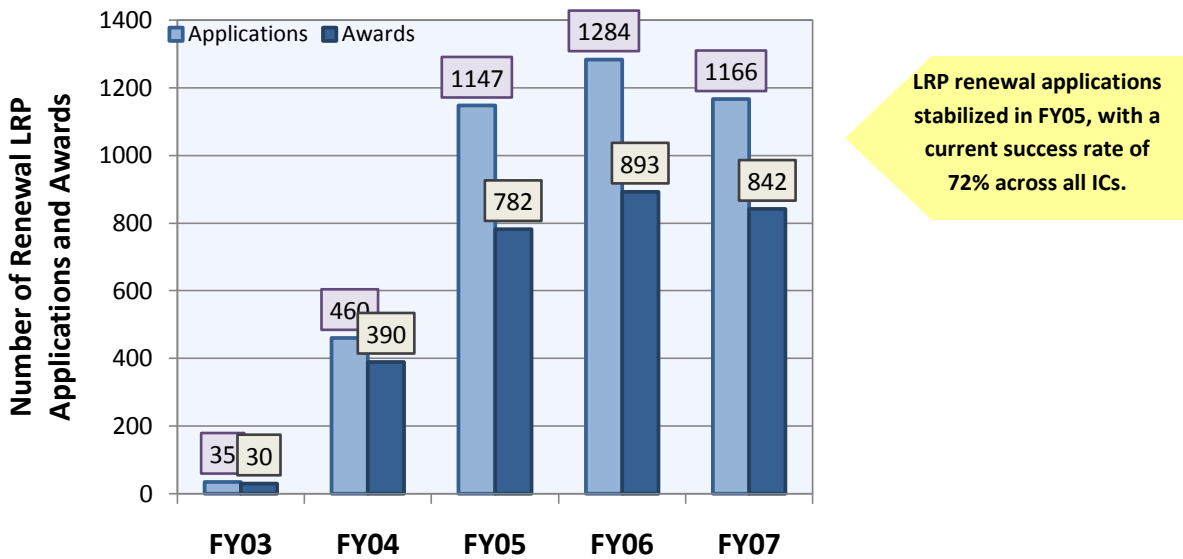
Figure 21. Number of renewal LRP applications and awards in each fiscal year, FY03-FY07.

Of all renewal applications received between FY2003-FY2007, 17% were submitted to NCMHD. NCI received 11%, NHLBI received 10%, and NIMH and NIAID each received 9% of renewal applications. The complete distribution of renewal applications and awards for each IC for the combined reporting period (FY2003-FY2007) is presented in **Appendix 1**.

1.4.2. Renewal applications and awards, by degree type

Table 6 shows the distribution of degree types for renewal applicants and awardees between FY2003-FY2007. Similar to new applications (Table 3), 9% percent of renewal applicants had a dual physician doctorate/academic doctorate; 3% had a professional clinical degree, while <1% were allied health professionals.

Table 6. Distribution of degree types for renewal extramural LRP applicants and awardees, FY03-FY07.

Degree Type	Renewal LRP Applications	% Renewal LRP Applications	Renewal LRP Awards	% Renewal LRP Awards	Success Rate
Physician Doctorate	1927	47%	1429	49%	74%
Professional Clinical Doctorate	116	3%	77	3%	66%
Academic Doctorate	1669	41%	1137	39%	68%
Physician Doctorate / Academic Doctorate	376	9%	293	10%	78%
Allied Health Professional	4	<1%	1	<1%	25%
Total	4,092		2,937		

1.4.3. Renewal applications and awards, by educational debt level

We next asked whether educational debt level correlates with the likelihood of obtaining a renewal award. **Table 7** shows the distribution of renewals by debt level. A quarter of initial awardees did not have a renewal award; 45% had one renewal award, 21% had two renewal awards, and 9.5% had three or more renewal awards. As debt increases, the likelihood of obtaining multiple renewals increases. While this seems intuitive, it also indicates that the LRP is enabling awardees with high debt to continue performing research during their debt repayment.

Table 7. Distribution of renewal awards by initial educational debt for extramural LRP awardees, FY03-FY07.

Debt Level	Number of Initial LRP Awardees	Total Number of Renewal Awards	% Awardees with no Renewals	% Awardees with only 1 Renewal	% Awardees with ≥ 2 Renewals	% Awardees with ≥ 3 Renewals
Less than $10K	22	12	45.5%	54.5%	0%	0%
$10K-$50K	1590	1658	26.6%	48.5%	24.9%	5.1%
$50K-$100K	1455	1790	23.4%	42.8%	33.7%	10.2%
$100K-$150K	982	1173	25.1%	45.2%	29.6%	10.1%
$150K-$200K	380	505	23.4%	40.0%	36.5%	13.9%
Over $200K	209	255	28.2%	37.3%	34.4%	13.9%

Summary of Findings:

FY03 – FY07 Extramural LRP Renewal Applicant Pool

Renewal Applications to the Extramural LRPs

- Between FY2003 – FY2007, LRP renewals comprised 29% of extramural LRP applications and 39% of all awards.
- Of the total renewal applications submitted in FY2003-FY2007, 17% were submitted to NCMHD, 11% were submitted to NCI, 10% were submitted to NHLBI, and NIMH and NIAID each received 9%.
- The Clinical Research and Pediatric Research LRPs received the majority of renewal applications.
- Overall success rate of renewal applications across LRPs is 72%.

Educational Background of Renewal Applicants

- Renewal applicants and awardees were similar to new applicants in terms of degree type, with 47% physician doctorates, 41% academic doctorates, and 9 % dual physician/academic doctorates.

Debt Levels of Renewal Applicants to the Extramural LRP

- A majority of LRP awardees obtain one or two renewal awards.
- LRP applicants with a higher debt load are more likely to obtain multiple renewal awards.

QUESTION 2 : DOES THE LRP RETAIN PARTICIPANTS IN THE NIH EXTRAMURAL WORKFORCE?

2.1 Goals

Investigate the effect of participation in the extramural Loan Repayment Programs on the retention of researchers in the extramural NIH-funded workforce.

2.2 Methods

Using priority scores – an NIH-wide quantitative metric – we identified two nearly-identical applicant groups for comparison: LRP applicants with similar priority scores, of which approximately half were funded and half were not funded. We employed a regression discontinuity design to examine the impact of receiving an LRP on subsequent involvement in the extramural NIH-funded workforce for funded and not funded LRP applicants.

These two cohorts were identified by selecting those applicants in the "funding bubble", i.e., applicants with similar priority scores who were equally likely to be funded as not funded. This concept is illustrated in **Figure 22**, showing the applicants that were selected for this analysis.
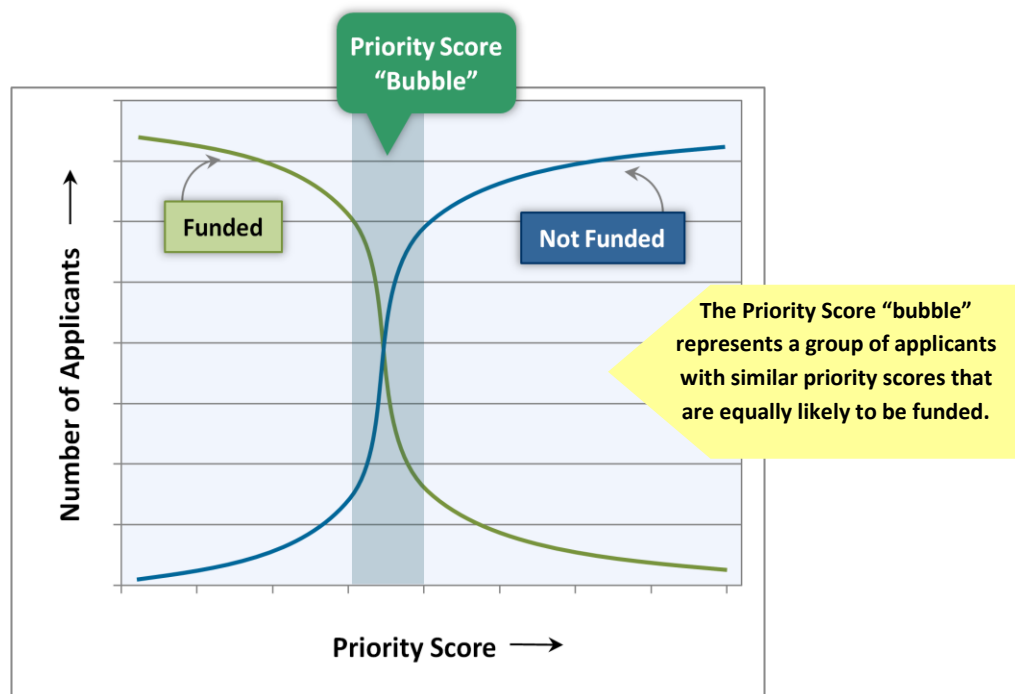
Figure 22. Identifying applicants on the "Funding Bubble". Applicants were identified for each FY between 2003-2006 for each IC. A total of 513 applicants were identified in this manner.

We identified the funding bubble for each IC between fiscal years 2003 and 2006. These bubbles were combined to form funded and not funded cohorts, then we applied regression discontinuity analysis to examine differences between these matched cohorts. Additional details and methodology concerning the construction of this matched sample are presented in **Appendix 3**.

Subsequent involvement in the extramural NIH research community was assessed by linking applicants in the study cohort to person records in the NIH grants database, Information for Management, Planning, Analysis, and Coordination (IMPAC II).[25] Details about the linkages between LRP applicants and IMPAC II profile records are provided in **Appendix 3**. For each applicant in the study cohort, IMPAC II was queried for Research Project Grant (RPG) applications and awards, Fellowship and Training Grant applications and awards, and participation in a research project in a role other than PI.[26] Subsequent participation is defined as at least one fiscal year following receipt of an LRP award.

Publication counts and citation rates provide an additional way to assess ongoing involvement in scientific research. The complete set of IMPAC II records for each applicant was used to construct a list of all known email addresses and name aliases for each applicant. This information was then used to retrieve publication records from MEDLINE by matching MEDLINE authors to IMPAC II profile(s) for each applicant. Additional information about the links between IMPAC II and MEDLINE is presented in **Appendix 3**.

2.3. Analysis of the Study Cohort

The study cohort included 513 individuals. The cohort was composed of two nearly-identical applicant groups, about half of whom were funded (n = 259) and half of whom were not funded (n = 254). We first determined if the study cohort and the full applicant population have similar composition with regard to gender, degree type, and years since qualifying degree. We also analyzed these demographics to determine if the funded and not funded cohorts were comparable.

2.3.1. Comparison of the study cohort and the total new applicant pool

To determine if applicants in the study cohort are representative of the total applicant pool, we analyzed three demographic parameters: gender, degree type, and years since qualifying degree (**Table 8**). The results show that (i) the degree distribution characteristics of the bubble are similar to the overall applicant pool, (ii) the distribution of men and women on the bubble is significantly different from the distribution of all new applicants (p=0.0044), and (iii) there are significantly more individuals in the bubble who completed their qualifying degree within three years prior to application (p<0.0001).

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[25] http://era.nih.gov/impacii/index.cfm.
[26] RPGs include activity codes starting with R, P, M, S, U (except UC6), G12, D42, DP1, and DP2. K awards were included in this group. All Type 9 grants were excluded. Fellowship and Training grants include activity codes starting with T, F, and G (except G12).

2.3.2. Comparison of funded and not funded applicants in the study cohort

We analyzed the same three parameters defined above to determine the similarity between the funded and not funded groups within the FY-IC Bubble. As shown in **Table 8**, these two groups are not significantly different in all categories listed and are valid comparison groups for all analysis of subsequent NIH grant participation and publication activity.

Table 8. Demographic distribution of funded and not funded applicants, and comparison to total new applicant pool.

Parameter	Category	% Funded IC-FY Bubble (n=259)	% Not Funded IC-FY Bubble (n=254)	% IC-FY Bubble (n=513)	% All New Applicants, FY03-FY07 (n=9820)
Gender	Male	41%	36%	**38%**	44%
	Female	57%	62%	**60%**	53%
Degree Type	Physician Doctorate	48%	46%	47%	47%
	Professional Clinical Doctorate	2%	6%	4%	5%
	Academic Doctorate	44%	45%	45%	42%
	Physician Doctorate / Academic Doctorate	5%	2%	3%	6%
	Allied Health Professional	1%	1%	1%	<1%
Years Since Degree	Up to 3 Years	52%	57%	**54%**	35%
	4-6 Years	34%	35%	35%	37%
	7-10 Years	11%	6%	**8%**	18%
	10+ Years	2%	3%	**3%**	10%

2.4. Subsequent Participation in NIH Grant Programs

Outcome analysis for the study cohort was carried out by determining subsequent participation in NIH grant programs. The analysis included a comparison of the funded and not funded groups and a more granular comparison of different demographic parameters.

2.4.1. Composite analysis

To determine if there was an overall difference between the funded and not funded groups, we performed a composite analysis as shown in **Figure 23**. The figure indicates the percentage of funded or not funded applicants in the study cohort who: applied and received a later NIH award (green); applied

but did not receive a later NIH award (orange); had another involvement in an NIH award (blue) [27]; or had an NIH award prior to an LRP award (olive). For those applicants with no other information in IMPAC II, we checked whether the applicant had served as a key person on an NIH research grant between FY2005-FY2007 (aqua).[28] The figure also shows the percentage of the group for whom no additional information was available in IMPAC II (grey). It should be noted that each category is mutually exclusive; if an applicant is accounted for in one category, that applicant is excluded from further consideration in any other category below it. Mutual exclusivity progresses in an order of decreasing importance of outcomes, from the top of the list to the bottom.

In comparing funded vs. not funded applicants, we found that funded LRP applicants were more likely to receive later NIH grant support than non-funded applicants (green bars, p=0.0102).
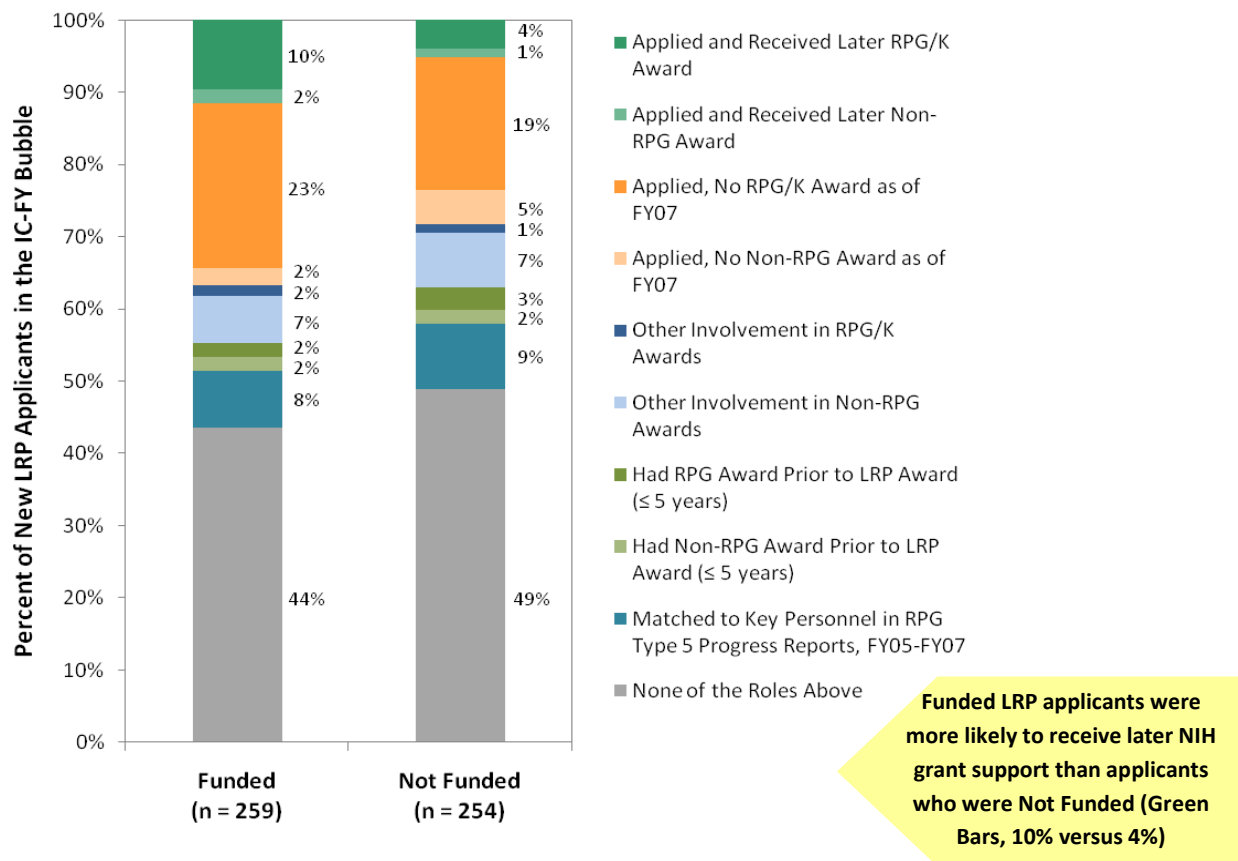
Figure 23. Composite analysis of outcomes for the funded and not funded groups in the study cohort.

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[27] "Other Involvement" means the applicant had a role on an awarded Research project in a fiscal year after their initial LRP application fiscal year, and one of the following two criteria was met: (1) They were not the PI (generally, this would mean they had a TA role), OR (2) the project for which they were PI was not a Type "1" application (which suggests they replaced a prior PI or were named PI on a continuation). Note that we excluded from this category those individuals who met criteria that qualified them for other outcome categories (applied and received later award or applied but no award).

[28] The Enumeration database was used for this purpose; for details on this database see: http://report.nih.gov/UploadDocs/Enumeration_DataReport_20081219.pdf.

2.4.2. Gender

We refined the analysis of subsequent NIH activity by considering gender as a categorical variable. Results of this analysis are presented in **Figure 24**. The analysis of the bubble applicants showed that women LRP awardees were less likely than men to have applied for an NIH award (p=0.0147)or to have a subsequent observable role in the NIH extramural program (p=0.474).
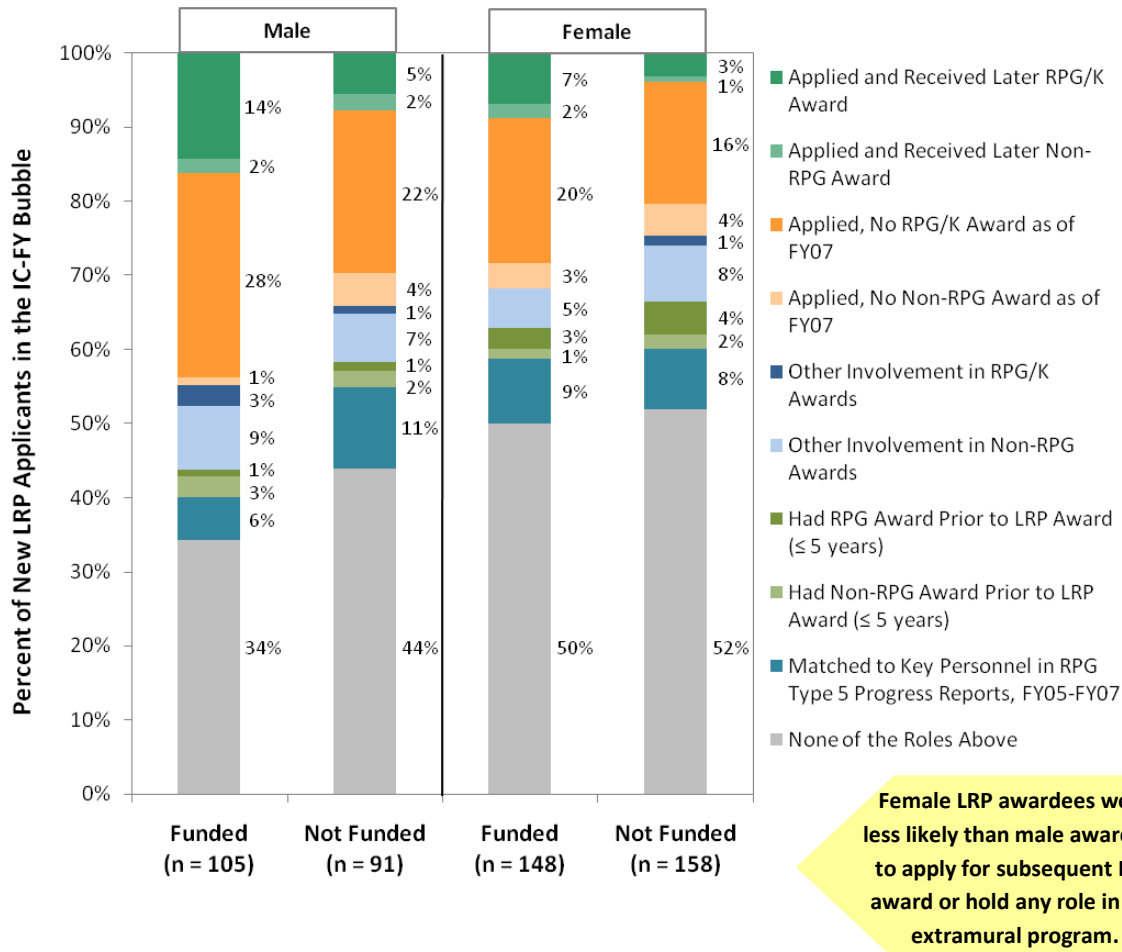
Figure 24. Analysis of outcomes, by gender, of subsequent NIH grant participation.

2.4.3. Degree Type

We next analyzed the impact of the applicant's qualifying degree on subsequent grant involvement. As shown in **Table 8**, academic doctorates comprise 45% of the total applicant pool, while physician doctorates comprise 50% of applicants. These degree types are similarly distributed between funded and not funded groups within the Bubble. Analysis of subsequent NIH grant involvement is shown in **Figure 25**.
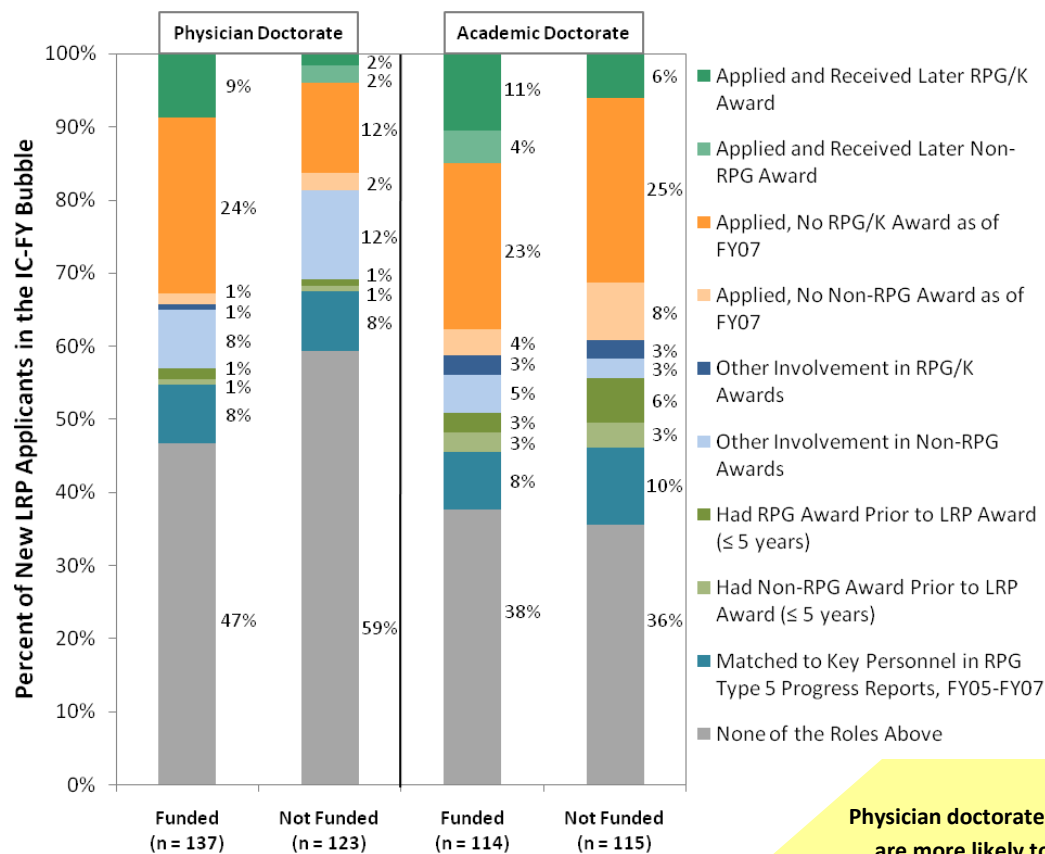
Figure 25. Analysis of outcomes, by degree type, of subsequent NIH grant participation.

Outcome analysis of subsequent NIH grant participation for academic doctorates and physician doctorates (which include dual physician doctorates- academic doctorates) indicates that significant differences occur by applicant degree. Participation in the LRP program increased the likelihood that a physician doctorate applied for a subsequent NIH award (p=0.0106) and was retained in the NIH extramural workforce (p=0.0470). While funded and non-funded academic doctorate were equally likely to apply for an NIH grant, participation in the LRP program increased the likelihood that an academic doctorate was awarded an NIH grant (p=0.0324).

2.4.4. Program

To determine if any difference exists between funded and not funded applicants in different LRPs, we compared applicants in the Clinical Research LRP and the Pediatric Research LRP. These two programs account for 78% of the applicants in the FY-IC Bubble (**Table 8**), and are roughly evenly balanced by degree type (**Figure 10**). Outcome analysis of subsequent NIH grant participation is shown in **Figure 26**.
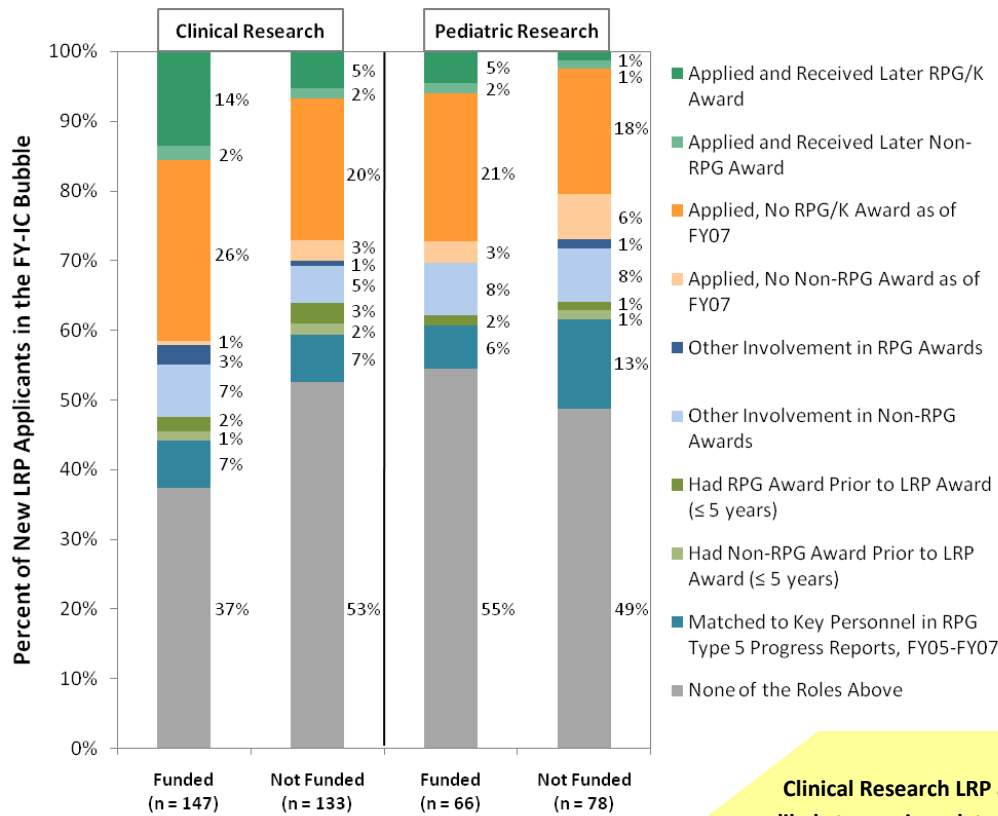
Figure 26. Analysis of outcomes, by degree type, of subsequent NIH grant participation.

As shown by the difference between the green area at the top of the Clinical Research bars, funded applicants to the Clinical Research LRP were significantly more likely to be awarded a subsequent NIH award (p=0.0236). Funded Clinical Research LRP applicants were also more likely to be retained in the extramural NIH workforce, as shown by the grey bars (p=0.0117). This analysis revealed no significant differences between funded and not funded Pediatric Research LRP applicants. This may be related to the difference in gender representation in the two programs (see Figure 9); the small sample size also affects statistical tests.

Summary of Findings

Analysis of the "Bubble" Cohort: Retention in the NIH Workforce

Comparison of the study cohort to the Total New Applicant Pool

- There are significantly more women in the study cohort (60%) than in the total new applicant pool (53%).
- The distribution of degree types is similar between the study cohort and the total new applicant pool.
- Significantly more individuals in the study cohort completed their qualifying degree within 3 years prior to applying to the LRP.

Comparison of Funded and Not Funded Applicants

- Within the study cohort, there was no significant difference in the distribution of gender, degree type, and years since degree between Funded and Not Funded applicants.

Subsequent Participation of Applicants in NIH Grant Programs

- Funded LRP applicants were more likely to receive later NIH grant support than those who were not funded.
- The LRPs are selectively losing women awardees.
- The LRPs are increasing the retention of physician doctorates in the NIH extramural workforce, both through increased grant applications and participation in research activities.
- Applicants funded in the Clinical Research LRP were significantly more likely to be awarded a subsequent NIH award than applicants funded in the Pediatric Research LRP.

2.5. Publications and Citations

Number of publications in scholarly journals is a standard quantitative measure of research productivity. We analyzed the number of articles published by study cohort applicants starting one fiscal year following their LRP application. Publications were matched to applicants based on the criteria described in Appendix 3. **Figure 27** shows the distribution of publications by funded and not funded applicants. Both groups show a similar pattern, with ~70% of the applicants publishing at least one article in a peer-reviewed journal.
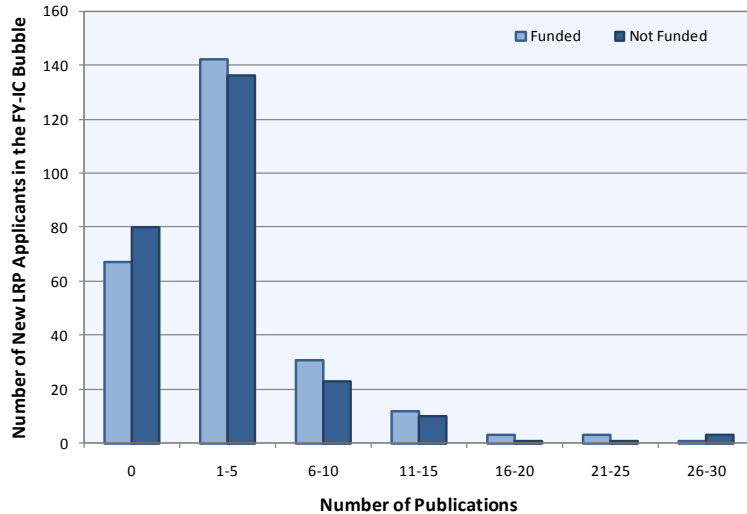
> **The majority of both Funded and Not Funded applicants published at least one peer reviewed journal article.**

Figure 27. Distribution of the number of articles published by applicants in the study cohort.

One concern with considering publication count as a measure of research output is the significant time needed to publish results. By considering the publication record for only those LRP applicants in the study cohort during the FY2003-FY2004 funding cycles, we analyzed the publication output for those applicants with the longest amount of time to accumulate publications, shown in **Figure 28**.
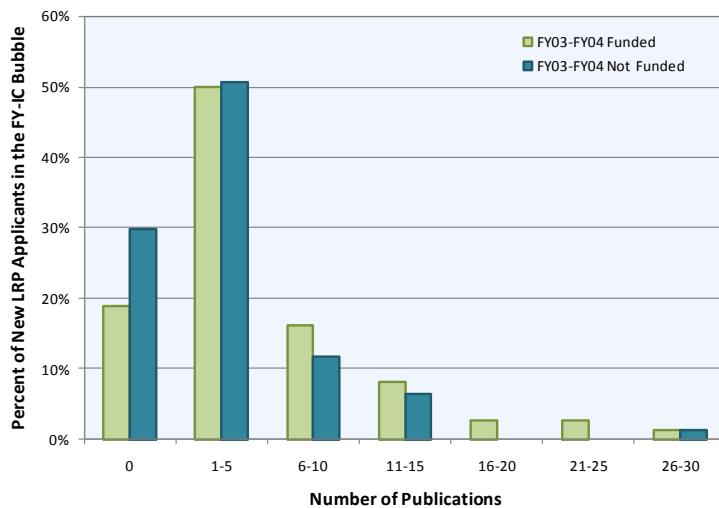
Figure 28. Distribution of the number of articles published by applicants in the study cohort for FY03-FY04.

These analyses suggest a trend toward differences in publication productivity between funded and not funded applicants. Nineteen-percent of funded LRP applicants had no publications compared to 30% of not funded applicants. Thirty-one percent of funded applicants had six or more papers, compared to 19% of not funded LRP applicants.

We also analyzed citation counts between the funded and not funded groups. As shown in **Figure 29**, there was no significant difference between these groups, either in the number of applicants with no subsequent citations or the number with five or more citations.
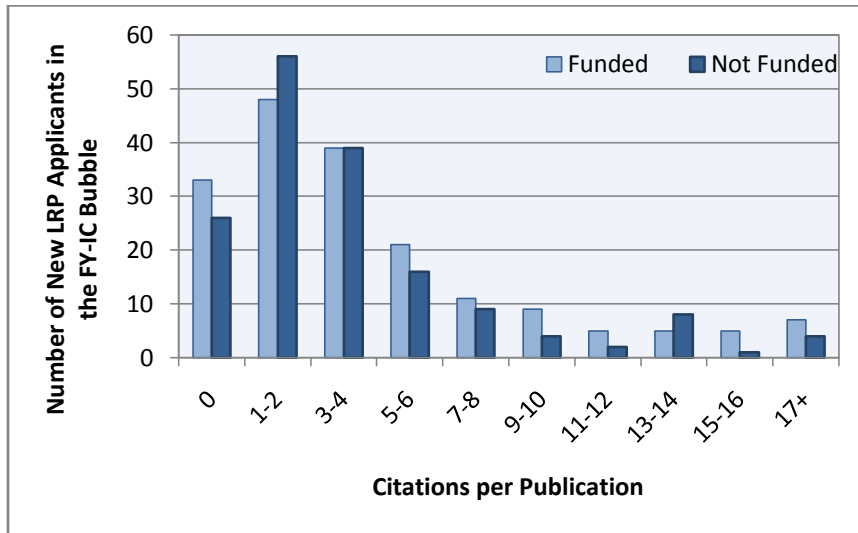
Figure 29. Distribution of the number of citations for articles published by applicants in the study cohort for FY03-FY08.

It would be worthwhile to repeat the publication and citation analyses after more time has elapsed to determine whether significant differences emerge between the groups.

Summary of Findings

Analysis of the "Bubble" Cohort: Publications and Citations

Comparison of Publication Productivity Between Funded and Not Funded Applicants

- The majority of both the Funded and Not Funded applicants published at least one article in a peer-reviewed journal.
- Preliminary evidence indicates that there may be differences in publication productivity between applicants who are funded or not funded, however the lack of a significant difference between the two groups may be accounted for by the timing of this evaluation.
- No significant difference in the number of citations per publication was detected between funded and not funded applicants.
- Allowing more time to elapse is necessary to test whether the timeframe of 1-4 years post-award is too short a time point to use as a measurement of productivity for LRP applicants.

2.6. Outcomes Analysis for Applicants without Subsequent NIH Records

The Bubble analysis showed that 44% of funded LRP applicants and 49% of those not funded had no post-LRP grant information available in IMPAC II. To learn more about the career outcomes of these individuals, Internet searches were conducted. Initial searches were conducted using the applicant name as stored in IMPAC II as the Google search engine query string. Depending on the number of hits returned, the middle name or initial and degree(s) were added or removed. In some cases, it was necessary to add the last known institution and/or academic department or field to the search terms, or to search PubMed for most recent affiliation information. The NIH Employee Directory (NED) and the professional networking site LinkedIn were also queried.

Confidence in the quality of information retrieved from the Web searches was established by the ability to find an individual on at least two recently updated websites. Individuals for whom this could be achieved were scored as a "High Confidence Match." Individuals for whom information could be confirmed through only one website were scored as a "Low Confidence Match." Individuals for whom information was out-of-date or could not be found were scored as "No Information" (**Table 9**).

Table 9. Available information on career outcomes for applicants without subsequent NIH Records.

	High Confidence Match	Low Confidence Match	No Information
Funded (n=113)	71.7%	18.6%	9.7%
Not Funded (n=124)	77.4%	8.9%	13.7%

2.6.1. Current Affiliation: Using the self-reported information from Web searches, the funded and not funded groups were compared to the information provided at the time of application for current affiliation and position. Information regarding additional funding sources was also recorded, if available. As shown in **Figure 30**, in both groups, over 50% were most likely to be at the same institution as when they applied to the LRP.
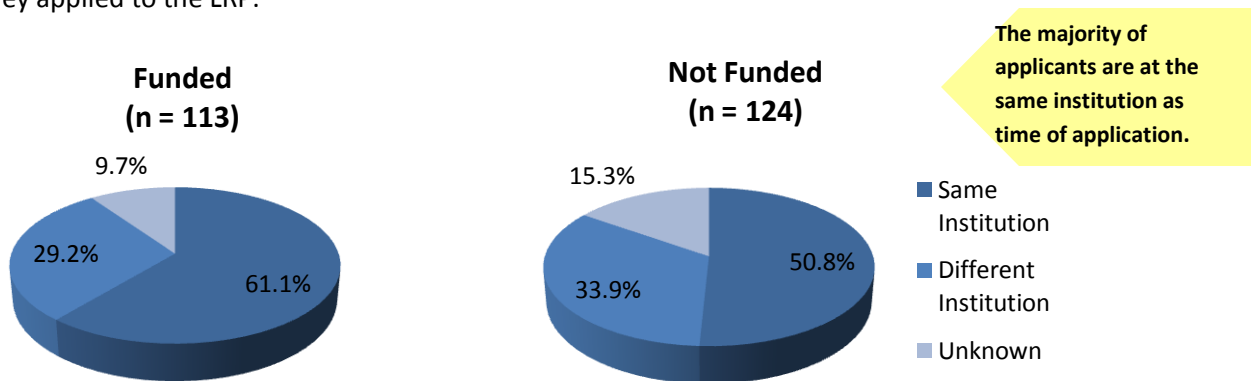
Figure 30. Current affiliation of applicants without subsequent NIH records.

2.6.2. Current Position: Professional titles for both the Funded and Not Funded groups were compared (**Figure 31**). Due to the breadth of titles, information was categorized as follows:

> ***Tenure Track:*** *Assistant, Associate, or Full Professor*
> ***Practitioner:*** *Attending Physician, Section Chief, Private Practice, or Clinical Instructor*
> ***Training:*** *Graduate Student, Post-Doctoral Fellow, Resident, or Other Medical Fellow*
> ***Other:*** *Administrative University Staff or Non-University Positions*
> ***Unknown:*** *Information not available or reported*

In both the Funded and Not Funded groups, approximately one-third held Tenure Track positions, and another one-third held Practitioner or Training positions.
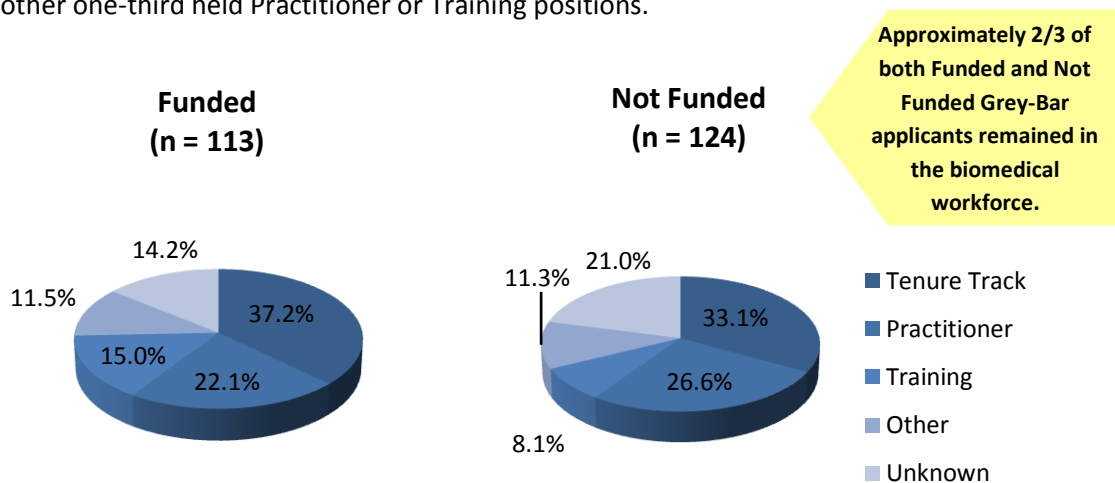
Figure 31. Current position of applicants without subsequent NIH records.

Summary of Findings

Analysis of the "Bubble" Cohort: Applicants without Subsequent NIH Records

- Bubble cohort analysis showed that 44% of Funded and 49% of Not Funded applicants had no post-LRP grant information in the NIH IMPAC II database.
- Current information for approximately 75% of these applicants was located through Internet searches.
- The majority of both the Funded and Not Funded applicants remain at the same institution as at the time of LRP application.
- In both the Funded and Not Funded Grey-Bar applicant groups, approximately one-third held tenure-track positions while another one-third held practitioner or training positions. Thus the majority of applicants without Subsequent NIH Records appear to have continued medical or biomedical careers.

3.1 Goals

Investigate the similarities and differences between the LRP and other NIH mentored career-development programs for early-career investigators, with regards to features of the application pool, retention rate in the NIH workforce, and publication rates.

3.2 Methods

The LRP was evaluated in comparison to a group of mentored career development awards, specifically the K01, K08, and K23 awards. Application priority scores were used to create mutually-exclusive comparison cohorts of the top-rated applicants: the top 10% of LRP awardees, the top 10% of K awardees, and the top 10% of LRP awardees who also received a K award. We derived these cohorts by identifying awardees with priority scores in the top 10% for each IC and each fiscal year from 2003 to 2006. **Figure 32** shows the definitions of the cohorts and the number of awardees in each group. Because of differences in the typical career stage of LRP and K awardees (see **Table 9** below), each cohort was restricted to awardees who earned their qualifying degree within six years prior to award receipt.

LRP Cohort	**K Cohort** K01, K08, K23	**LRP+K Cohort**
Funded Type I awardees, FY03-FY06 Top 10% priority score, each FY/IC Within 6 years of degree *L awards only*	Funded Type I awardees, FY03-FY06 Top 10% priority score, each FY/IC Within 6 years of degree *K awards only*	Funded Type I awardees, FY03-FY06 Top 10% priority score, each FY/IC Within 6 years of degree *L and K awards*
LRP Top-10% *n = 157*	**K Top-10%** *n = 101*	**LRP+K Top-10%** *n = 39*

Figure 32. Definitions of each comparison cohort and the number of awardees in each group.

For each of the top 10% cohorts, we examined subsequent NIH grant participation and publication productivity as described for the funding bubble cohorts. The only difference for this analysis was that K awards were not counted as subsequent grants for any of the three groups.

3.3 Demographic Distribution

We analyzed gender and degree type distributions of each cohort to determine if the cohorts were similar. Demographics for the top 10% group are summarized in **Table 10.** While the

gender distribution is about equal between and across groups, there were substantial differences in degree distribution and years since degree between the LRP, K, and K+LRP cohorts. The top 10% LRP awardee group is evenly split between Academic and Physician Doctorates (including dual degree holders), while the K and K+LRP awardee groups are both 2/3 Physician Doctorates (p<0.01) (these differences are highlighted in bold text in theTable 10). The top 10% LRP awardee group is fewer years from degree than either the K or K+LRP group. To increase similarity between groups, we narrowed our examination of outcomes to awardees within six years of receiving their qualifying degree (**Table 11**).

Table 10. Demographic distribution of total LRP, K, and LRP+K Top-10% awardee cohorts.

Parameter	Category	LRP Top 10% (n=215)	K Top 10% (n=218)	LRP+K Top 10% (n=96)
Gender	Male	44%	51%	46%
	Female	51%	49%	47%
Degree Type	Physician Doctorate	31%	32%	**50%**
	Professional Clinical Doctorate	0%	0%	0%
	Academic Doctorate	**52%**	36%	33%
	Physician Doctorate / Academic Doctorate	16%	**32%**	15%
	Allied Health Professional	0%	0%	0%
Years Since Degree	Up to 3 Years	**34%**	15%	24%
	4-6 Years	39%	32%	17%
	7-10 Years	17%	28%	**43%**
	10+ Years	10%	20%	17%

Table 11. Demographic distribution of the 0-6 YSD LRP, K, and LRP+K Top-10% awardee cohorts

Parameter	Category	LRP Top-10%, 0-6 Years Since Degree	K Top-10%, 0-6 Years Since Degree	LRP+K Top-10%, 0-6 Years Since Degree
Gender	Female	**50%**	**51%**	**72%**
	Male	45%	49%	26%
Degree Type	Physician Doctorate	**26%**	**16%**	**15%**
	Professional Clinical Doctorate	**1%**	**3%**	**5%**
	Academic Doctorate	**60%**	**52%**	**67%**
	Physician Doctorate / Academic Doctorate	**12%**	**29%**	**13%**
	Allied Health Professional	**1%**	**0%**	**0%**

3.3.1. Gender

Figure 33 shows that the proportion of men and women in the LRP Top-10% and K Top-10% awardee cohorts are similar. The gender distribution in the LRP+K Top-10 awardee cohort is different, with 70% of this group being women.

> The gender distribution among LRP Top-10% and K Top-10% was similar, but more women (70%) were in the LRP + K group.
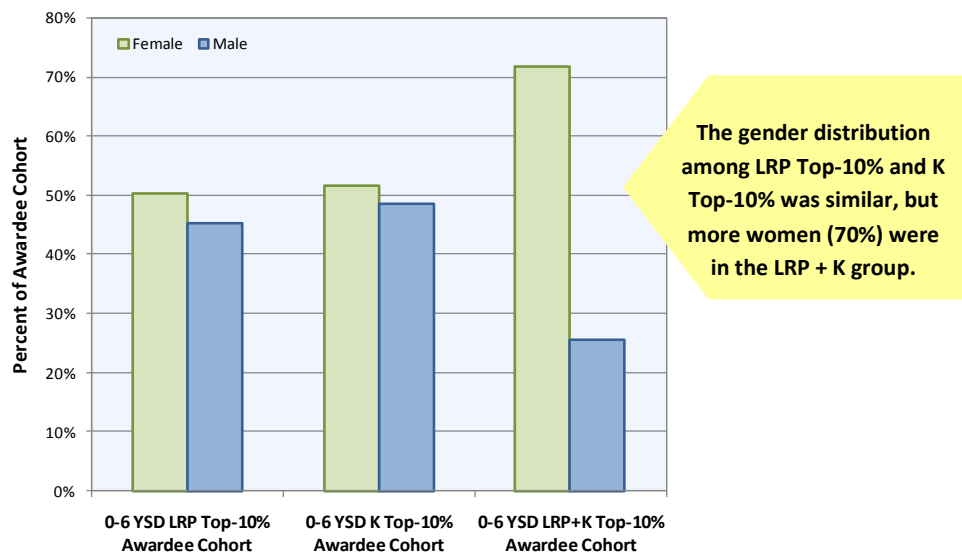
Figure 33. Gender distribution of LRP, K, and LRP+K Top-10% awardee cohorts.

3.3.2. Degree type

The distribution of academic doctorates and physician doctorates (which includes dual physician doctorates-academic doctorates) is shown in **Figure 34**. Degree distribution is not significantly different across the cohorts of awardees.
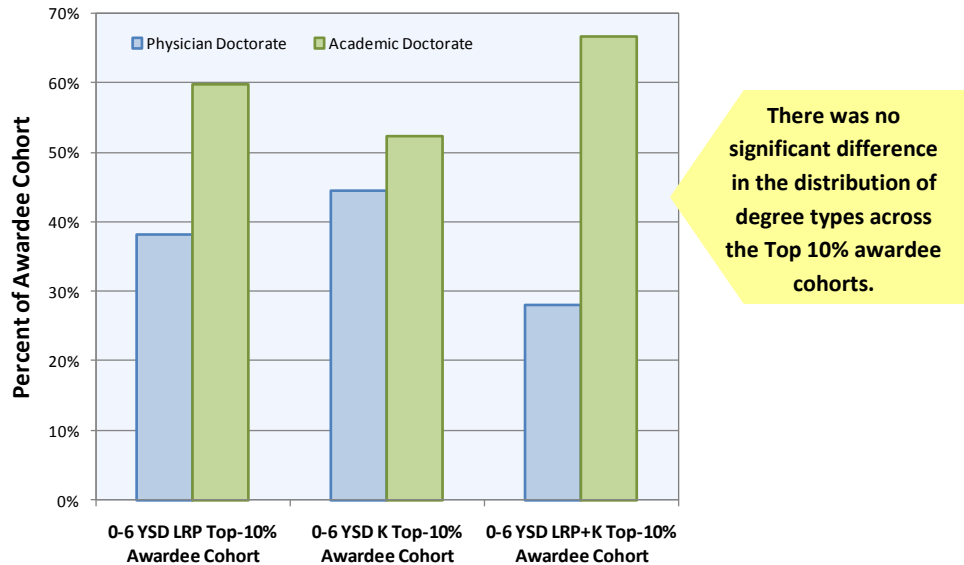
Figure 34. Distribution of degree type of the LRP, K, and LRP+K Top-10% awardee cohorts.

3.4. Subsequent Participation in NIH Grant Programs

Outcome analysis of the Top-10% comparison cohorts was carried out by determining subsequent participation on NIH grants, similar to the analysis for the Bubble applicants. The analysis included a comparison of each cohort, and a more granular comparison of demographic parameters (gender and degree type).

3.4.1. Composite Analysis

To determine if there was an overall difference between the LRP, the K, and the LRP+K Top-10% awardee cohorts, we performed a composite analysis as shown in **Figure 35**. The figure indicates the percentage of awardees that applied and received a later NIH award (green); applied but did not receive a later NIH award (orange); had another involvement in an NIH award (blue); or had an NIH award prior to an LRP award (olive).[29] For those applicants with no other information in IMPAC II, we checked whether the applicant had served as a key person on an NIH research grant between FY2005-FY2007 (aqua).[30] The figure also shows the percentage of the group for whom no additional information was available in IMPAC II (grey). Each category is mutually exclusive; an applicant accounted for in one category is excluded from further consideration in any other category below it. Mutual exclusivity progresses in an order of decreasing importance of outcomes, from the top of the list to the bottom.

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[29] Note that for the Top 10% cohort analysis, unlike the Bubble, "later NIH award" does not include K awards.
[30] The Enumeration database was used for this purpose; for details on this database see:
http://report.nih.gov/UploadDocs/Enumeration_DataReport_20081219.pdf.
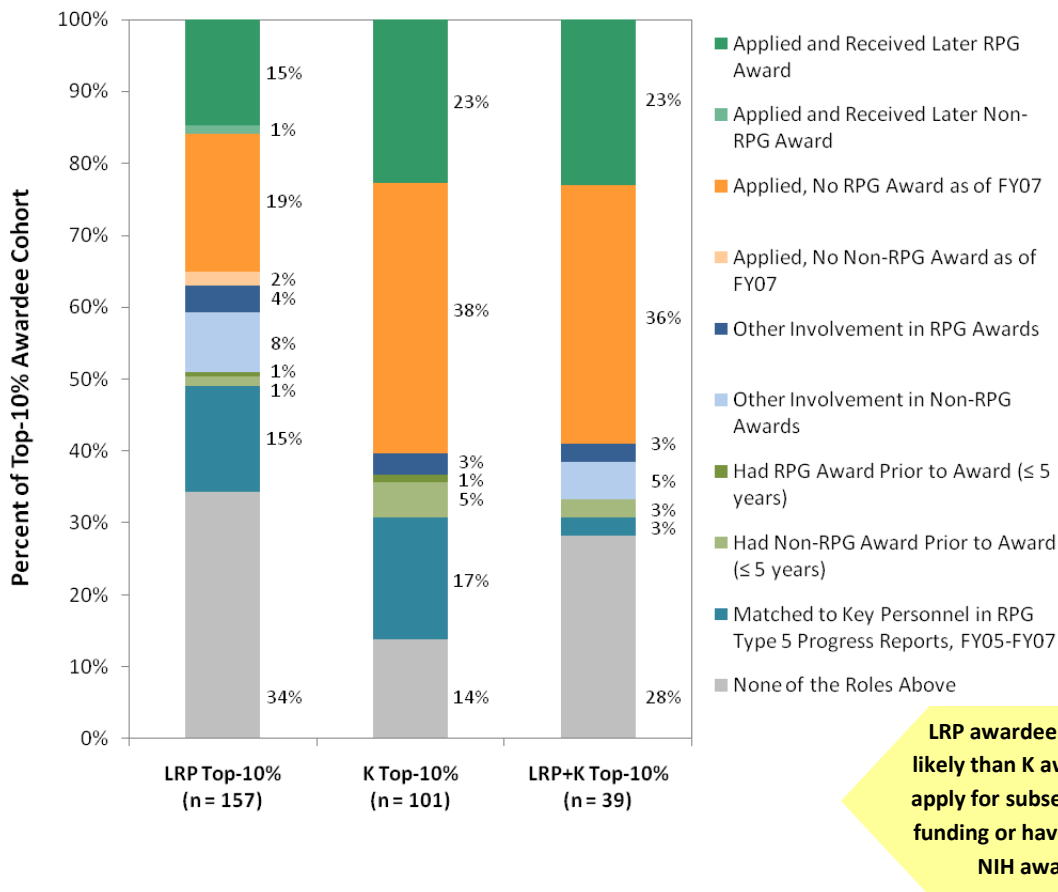
Figure 35. Composite analysis of outcomes for the LRP, K, and LRP+K Top-10% awardee cohorts.

While the LRP has a significant effect on the likelihood of applying for NIH funding (see Figure 23), when compared to other NIH career development awards, LRP recipients are less likely to apply for subsequent NIH funding. This is shown by the significant difference in the total green and orange area between the LRP and K awardees (p = 0.0003) and between the LRP and LRP+K awardees (p = 0.0176). LRP awardees are also less likely than K awardees to have a subsequent role on NIH awards (difference in size of grey bars between LRP and K awardees; p = 0.0003). It should be noted that, while many K awardees hold faculty positions, LRP recipients may or may not be in a position where they can apply for NIH research project grants.

3.4.2. Gender
We refined the analysis of subsequent involvement by considering the gender of awardees in the LRP and the K Top-10% awardee cohorts (**Figure 36**). The LRP+K Top-10% awardee cohort was excluded from this analysis because of the small sample size.

Figure 36. Analysis of outcomes, by gender, of subsequent NIH grant participation of the LRP and the K Top-10% awardee cohort.
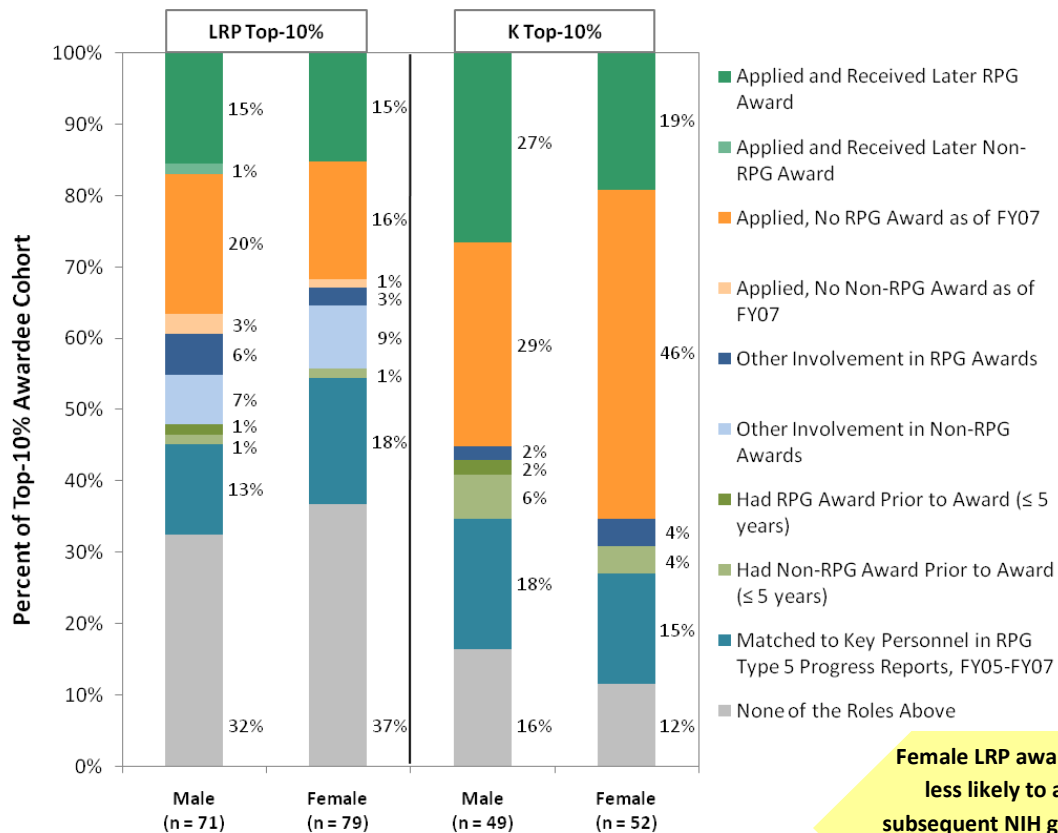
Unlike the Bubble cohort, there were no significant differences in outcome measures between top 10% LRP cohort men and women. When compared to top 10% K awardees, top 10% women LRP awardees were less likely to apply for subsequent NIH grant support within 1-4 years after award, as indicated by the difference in the green and orange areas at the top of the female bars (p = 0.0003). They were also less likely than the women K awardees to have a subsequent role on an NIH award, shown by the difference in the size of the grey areas at the bottom of the female bars (p = 0.0013).

3.4.3 Degree type

We analyzed the impact of the awardee's qualifying degree on subsequent grant involvement. As above, the LRP+K Top-10% awardee cohort was excluded from this analysis because of the small sample size. Results of this analysis are shown in **Figure 37**.

Figure 37. Analysis of outcomes, by degree type, of subsequent NIH grant participation of the LRP and the K Top-10% awardee cohort.
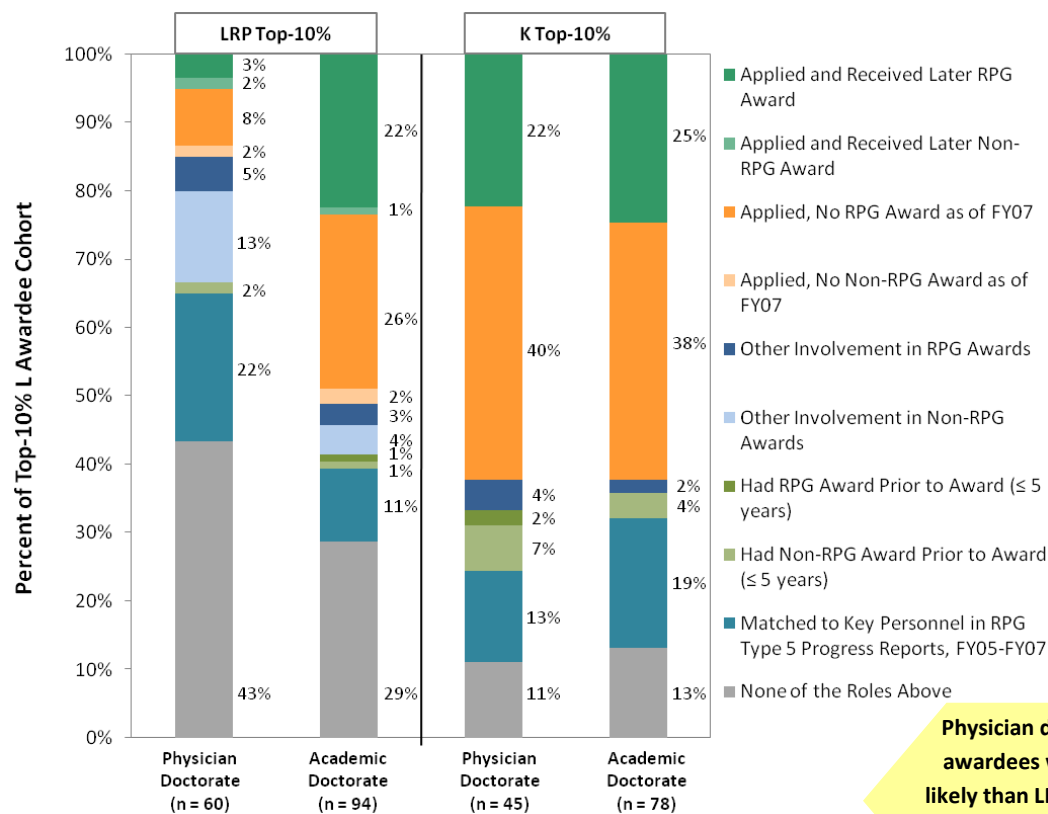
While participation in LRPs has a strong retention effect for physician doctorates (see Figure 25), this effect is even stronger for K awardees. Among physician doctorate awardees, LRP awardees were less likely than K awardees to apply for or receive subsequent NIH funding. The difference in grant awards is indicated by the difference in the green areas at the top of the physician doctorate bars (p=0.0141), and the difference in grant applications is indicated by the difference in orange areas in the physician doctorate bars (p = 0.0001). Among both academic doctorates and physician doctorates, LRP awardees were less likely than K awardees to have subsequent involvement on NIH grants (indicated by the size of the grey bars; physician doctorate, p = 0.0004; academic doctorate p = 0.0018).

3.5. Publications and Citations

We analyzed the number of articles published by awardees in each of the three Top-10% comparison cohorts, shown in **Figure 38**. Publications appearing in peer-reviewed journals one fiscal year following their LRP award were identified and were matched to applicants based on the criteria described in Appendix 3. All awardee cohorts have been contributing to biomedical research, with about 90% of awardees in each cohort publishing at least one article in peer-reviewed journals. During the timeframe under study, more K awardees published six or more papers than LRP awardees (p = 0.0001).

Figure 38. Distribution of the number of articles published by the LRP, K, and LRP+K Top-10% awardee cohorts.

An analysis of citations (**Figure 39**) indicates that in the K group, more awardees have more citations per publication than in the LRP group (p < 0.01). Using the citation/publication measure normalizes the results and allows for a comparison between groups with unequal numbers of publications.

Figure 39. Distribution of the number of citations for articles published by the LRP, K, and LRP+K Top-10% awardee cohorts.

Summary of Findings

Comparison of LRP with Mentored K Awards: Top 10% Cohort Analysis

Similarities and Differences of Outcomes among LRP and the K Award Recipients

- Overall, the top 10% of LRP awardees are more likely to be Academic Doctorates and to be within 3 years of degree conferral than either K or LRP+K top 10% awardees. This strongly suggests that the LRP is attracting applicants that are earlier in their research careers than the K awards program.
- The K awardees were more likely to apply for grant support within 1-4 years after award than the LRP awardees. This follows from the previous finding that the LRP awardees are in a less mature career stage than K awardees and may need additional time to produce research results capable of supporting an RPG application.
- Gender distribution among the top 10% of awardees was similar for LRP and K awardees. However, female K awardees were more likely than their LRP counterparts to apply for subsequent NIH grant support and to be retained in the NIH extramural workforce 1-4 years after award.
- Similarly, even though the LRP has a clear retention effect on physician doctorates, K awardee physician doctorates were more likely to apply for and receive subsequent funding, and to be retained in the NIH extramural workforce 1-4 years after award.

APPENDIX 1 : DETAILS BY IC

A1.1. New and Renewal Applications and Awards, by IC

Twenty four Institutes and Centers (IC) sponsored LRP awards between FY2003 and FY2007. The complete distribution of new applications and awards at each IC is presented in **Table A1.1**.

Table A1.1. Distribution (number and percent of total) of new extramural LRP applications and awards at each IC, FY03-FY07

IC	New LRP Applications	% New LRP Applications	New LRP Awards	% New LRP Awards
FIC	2	<1%	2	<1%
NCCAM	96	1%	20	<1%
NCI	1,231	13%	508	11%
NCMHD	1,485	15%	757	17%
NCRR	193	2%	137	3%
NEI	124	1%	106	2%
NHGRI	14	<1%	12	<1%
NHLBI	1,103	11%	543	12%
NIA	314	3%	171	4%
NIAAA	159	2%	131	3%
NIAID	652	7%	340	7%
NIAMS	257	3%	117	3%
NIBIB	26	<1%	9	<1%
NICHD	1,016	10%	395	9%
NIDA	338	3%	241	5%
NIDCD	134	1%	112	2%
NIDCR	85	1%	46	1%
NIDDK	829	8%	258	6%
NIEHS	63	1%	38	1%
NIGMS	91	1%	39	1%
NIMH	1,060	11%	396	9%
NINDS	436	4%	155	3%
NINR	65	1%	9	<1%
NLM	47	<1%	23	1%
Total	9,820		4,565	

All ICs that sponsored new awards during the FY2003-FY2007 period also sponsored renewal awards. The complete distribution of renewal applications and awards at each IC is presented in **Table A1.2**.

Table A1.2. Distribution (number and percent of total) of renewal extramural LRP applications and awards at each IC, FY03-FY07

IC	Renewal LRP Applications	% Renewal LRP Applications	Renewal LRP Awards	% Renewal LRP Awards
FIC	2	<1%	2	<1%
NCCAM	26	1%	23	1%
NCI	461	11%	307	10%
NCMHD	715	17%	496	17%
NCRR	160	4%	135	5%
NEI	72	2%	64	2%
NHGRI	18	<1%	15	1%
NHLBI	421	10%	325	11%
NIA	166	4%	121	4%
NIAAA	116	3%	98	3%
NIAID	380	9%	292	10%
NIAMS	84	2%	66	2%
NIBIB	4	<1%	2	<1%
NICHD	267	7%	175	6%
NIDA	278	7%	207	7%
NIDCD	54	1%	48	2%
NIDCR	33	1%	25	1%
NIDDK	208	5%	110	4%
NIEHS	38	1%	33	1%
NIGMS	21	1%	16	1%
NIMH	386	9%	260	9%
NINDS	167	4%	108	4%
NINR	6	<1%	5	<1%
NLM	9	<1%	4	<1%
Total	4,092		2,937	

A1.2. New Applications and Awards, by IC and LRP

The National Center on Minority Health and Health Disparities (NCMHD) receives all applications submitted to the Health Disparities Research LRP and the Clinical Research LRP for Individuals from

Disadvantaged Backgrounds. All applications submitted to the Contraception and Infertility Research LRP are received by the National Institute of Child Health and Human Development (NICHD). Twenty three ICs (all listed in the above table except NCMHD) support the Clinical Research LRP and the Pediatric Research LRP. **Table A1.3** lists the success rate of new Clinical Research LRP applications for all ICs during the evaluation period (FY2003 – FY2007). **Table A1.4** presents the same information for the Pediatric Research LRP.

Table A1.3. Success rate of new Clinical Research LRP applications by IC, FY03-FY07.

Success rate of new Clinical Research LRP applications (Number of ICs)	IC (% of new Clinical Research LRP awards)
Up to 50% (4)	NICHD (35%)[31], FIC (50%)[32], NIEHS (50%)
51%-74% (10)	NIDDK (53%), NINR (56%), NIGMS (59%), NIDCR (63%), NCRR (65%), NIAID (65%), NHLBI (66%), NINDS (66%), NIAMS (71%), NIDCD (71%)
Greater than 75% (10)	NHGRI (75%), NEI (75%), NIMH (79%), NCI (81%), NIDA (85%), NIAAA (85%), NIBIB (89%), NLM (96%), NIA (99%), NCCAM (100%)

Table A1.4. Success rate of new Pediatric Research LRP applications by IC, FY03-FY07.

Success rate of new Pediatric Research LRP applications (Number of ICs)	IC (% of new Pediatric Research LRP awards)
Up to 20% (8)	NCCAM (0%), NIA (1%), NLM (4%), NIBIB (11%), NIAAA (15%), NIDA (15%), NCI (19%)
21%-40% (10)	NIMH (21%), NEI (25%), NHGRI (25%), NIDCD (29%), NIAMS (29%), NINDS (34%), NHLBI (34%), NIAID (35%), NCRR (35%), NIDCR (37%)
41%-50% (6)	NIGMS (41%), NINR (44%), NICHD (46%), NIDDK (47%), FIC (50%), NIEHS (50%)

A1.3. New Awards, by IC and Degree Category

Nineteen ICs do not state a preference for a degree category in awarding LRP contracts. To analyze the relationship between stated preference and actual awards, we categorized the ICs into three groups based on the proportion of physician doctorates and academic doctorates receiving new awards (**Table A1.5**).

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[31] NICHD is the only IC that funds the Contraception and Infertility Research LRP.
[32] Only two new awards made during the reporting period: one new award in FY04, and one new award in FY05.

Table A1.5. Percent of new extramural LRP awards to physician doctorates and academic doctorates by IC, FY03-FY07.

IC Category (Number of ICs)	IC (% of new LRP awards with certain degree)
ICs where physician doctorates received >65% of new LRP awards (6)	NIAMS (71%), NLM (78%), NCI (79%), NCRR (83%), NHLBI (84%), NIDDK (87%)
ICs where academic doctorates received >65% of new LRP awards (7)	NIMH (68%), NCMHD (69%), NIDCD (72%), NHGRI (75%), NIDA (78%), NIAAA (82%), NINR (100%)
ICs where a single degree type did not predominate the new LRP awardee pool (6)	FIC, NCCAM, NEI, NIA, NIDCR, NIEHS

This analysis shows that of the 19 ICs that did not state a preference for a certain degree category, six (FIC, NCCAM, NEI, NIA, NIDCR, and NIEHS) did not have a single degree category predominate the awardee pool.   Seven showed a preference for awarding academic doctorates and 6 showed a preference for awarding physician doctorates.

APPENDIX 2 : DEGREE CLASSIFICATIONS

The extramural Loan Repayment Program attracts applicants with a wide variety of degree types.[33] We classified these degrees into five categories (**Table A2.1**) to facilitate cross-parameter analysis of degree type with gender, program, IC, years since degree and educational debt level.

Table A2.1. Classification of LRP applicant degrees.

	Degree Category	Degrees Included
1	**Physician Doctorate**	M.D., D.O.
2	**Professional Clinical Doctorate**	D.D.S., D.M.D., D.P.M., D.P.T., D.V.M., N.D., O.D., Pharm.D., Psy.D., V.M.D.
3	**Academic Doctorate***	Ph.D., D.C., D.N.Sc., D.P.H., Dr.P.H., D.Sc., D.S.W., Ed.D., Eng.D., J.D., Sc.D.
4	**Physician Doctorate / Academic Doctorate**	Any combination of (1) and (3), e.g., M.D./Ph.D., D.O./Ph.D., M.D./Ed.D.
5	**Allied Health Professional**	A.B., B.A., B.S., B.S.N., M.A., M.B.A., M.L.S., M.P.A., M.P.H., M.S., M.S.N., R.N.

*Includes dual doctorate combinations from (2) and (3), e.g., D.M.D./Ph.D., Pharm.D./Sc.D.

Physician doctorates were distinguished from other clinical professionals; the former group comprised M.D. and D.O. (and equivalent) degrees, while the latter group included related medical degrees (e.g., naturopathy, podiatric medicine, optometry, and psychology), dental, veterinary, and pharmacy degrees. Academic degrees included doctorates in chiropractic medicine, nursing, public health, social work, education, engineering, law, science, and the doctorate in philosophy.

Table A2.2 presents the full degree names for those degree types classified in **Table A2.1**.

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[33] While a doctoral-level degree is a prerequisite for submitting an LRP application, the Contraception and Infertility Research LRP accepts applications from non-doctoral-level allied health professional degree holders, defined as those individuals with a bachelor's and/or master's degree in a relevant discipline.

Table A2.2. Degree definitions and classifications.

Degree Category	Degree Code	Degree
Physician Doctorate	D.O.	Doctor of Osteopathy
	M.D.	Doctor of Medicine
Professional Clinical Doctorate	D.D.S.	Doctor of Dental Surgery
	D.M.D.	Doctor of Medical Dentistry
	D.P.M.	Doctor of Podiatric Medicine
	D.P.T.	Doctor of Physical Therapy
	D.V.M.	Doctor of Veterinary Medicine
	N.D.	Doctor of Naturopathy
	O.D.	Doctor of Optometry
	Pharm.D.	Doctor of Pharmacy
	Psy.D.	Doctor of Psychology
	V.M.D.	Doctor of Veterinary Medicine
Academic Doctorate	D.C.	Doctor of Chiropractic
	D.N.Sc.	Doctor of Nursing Science
	D.P.H.	Doctor of Public Health
	Dr.P.H.	Doctor of Public Health
	D.Sc.	Doctor of Science
	D.S.W.	Doctor of Social Work
	Ed.D.	Doctor of Education
	Eng.D.	Doctor of Engineering
	J.D.	Juris Doctor
	Ph.D.	Doctor of Philosophy
	Sc.D.	Doctor of Science
Allied Health Professional Degree	A.B.	Bachelor of Arts
	B.A.	Bachelor of Arts
	B.S.	Bachelor of Science
	B.S.N.	Bachelor of Science In Nursing
	M.A.	Master of Arts
	M.B.A.	Master of Business Administration
	M.L.S.	Master of Library Science
	M.P.A.	Master of Public Administration
	M.P.H.	Master of Public Health
	M.S.	Master of Science
	M.S.N.	Master of Science In Nursing
	R.N.	Registered Nurse

APPENDIX 3 : DETAILED OUTCOMES METHODS

Section 2 presented outcome analyses for matched cohorts of funded and not funded LRP applicants. These analyses required us to identify appropriate applicants, match these applicants with records in IMPAC II, and identify publications authored by the applicants. All matches were manually reviewed for accuracy. Similar methods were used for the analyses presented in Section 3.

A3.1. Construction of the Funding Bubble

We developed a method to identify candidates for these cohorts based on the priority score of the candidate's application. The two cohorts were identified by selecting those applicants in the "funding bubble", which are those applicants with similar priority scores who were equally likely to be funded or not funded. Since this priority score range depends on fiscal year and IC, we identified candidate applicants for each FY and IC. The candidates identified were combined into one bubble comprised of funded and not funded cohorts (513 applicants; 259 funded, 254 unfunded).

The priority score range that defined the funding bubble was determined for each IC (24), for each fiscal year between FY2003 and FY2006 (4 years). For each IC and each fiscal year, the priority score range (100 - 500) was divided into equal sized bins and each bin was populated with the number of funded and not funded applicants, respectively. An ideal bubble bin would contain equal numbers of funded and not funded applicants; one would expect bins at the low end of the priority score range to be dominantly populated by funded applicants and bins at the high end of the priority score range to contain mostly not funded applicants. Since the optimal bin width is dependent on a number of factors, including the total number of applicants in a particular FY-IC and the particular use of priority score to determine funding (e.g., gradual vs. a sharp threshold) the process was repeated with different bin widths. The minimum, and preferred, bin width was a score range of 5 (80 bins over the 100-500 range) and the maximum allowed bin width was a score range of 30 (13 bins). Six different bin widths were considered for each FY-IC. After the nearly 200 bin occupancies were determined for a particular FY-IC, the optimal bubble bin was selected using the following scoring function:

$$\left(\frac{Applications\ in\ Bin}{Ratio}\right) \times \left[1 - \left(0.15 \times (Score\ Range - 1)\right)\right]$$

where *Applications in Bin* is the total number of the funded and not funded applicants in the bin, *Ratio* is the ratio of funded and not funded applicants in the bin, and *Score Range* is the score range of the bin (ranges from 5 - 30). This function is designed to preferentially select bins (by returning a high score) that contain a large number of applicants, contain a 1:1 ratio of funded to not funded applicants, and have a narrow score range.

Bins were not available for every IC and every fiscal year due to the lack of a score range and/or the lack of appropriate candidate bins. We determined that a minimum of four applicants (two funded and two not funded) was necessary for a functional funding bubble; bins that did not meet this criterion were discarded. Of the remainder, the bin with the highest score for each IC in each fiscal year was selected to represent the funding bubble for that IC in that fiscal year. Individual funding bubbles were combined to form a composite FY-IC Bubble consisting of 513 applicants. Of these, 259 applicants were funded and 254 applicants were not funded. This process is shown in **Figure A3.1**.
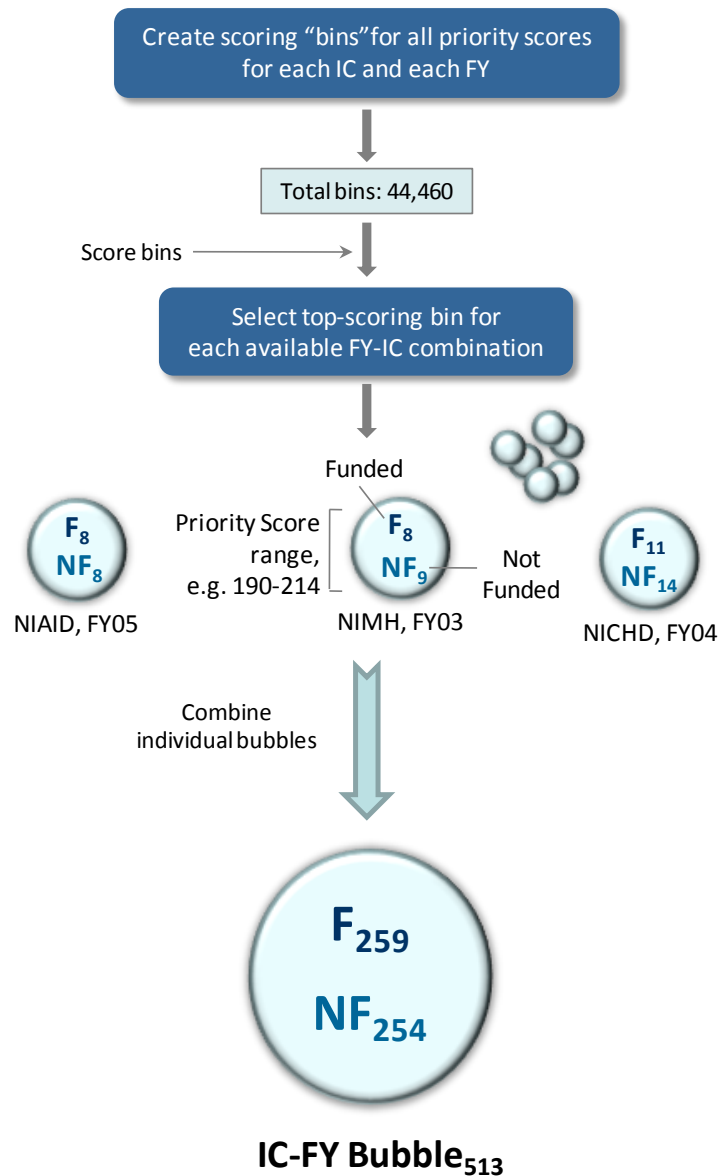

Figure A3.1. Schematic outline of the steps used for the generation of the FY-IC Bubble.

A3.2. Determination of Subsequent NIH Activity

For each applicant in the IC-FY Bubble, the NIH grants database, IMPAC II, was queried for subsequent Research Project Grant (RPG) and Fellowship and Training Grant applications, awards, or non-PI participation. Subsequent participation is defined as activity at least one fiscal year following receipt of an LRP award.[34]

An attempt was made to identify all IMPAC II profile records for each applicant. Although the IMPAC II architecture is intended to use one record per person, there are a number of ways by which multiple profiles are created. Therefore, one or more IMPAC II profile records were linked to each LRP applicant using the following criteria, all of which had to be satisfied:

1. *Last Names:* The last names in different profiles were matched. If more than one last name was present in the profile, then one last name had to be a prefix of the other and the applicant's social security number or date of birth had to match. Alternatively, both the applicant's social security number and date of birth had to match.

2. *First Name:* There could be no conflict in the first names; either the first names matched exactly, one was a prefix of the other, only matching initials were provided for both, one of the first names was missing, or the first name could be found in the middle or last name of the candidate match. (The last criteria accounts for possible first/middle/last name swaps).

3. *Middle Name:* There could be no conflict in any provided middle names, using the same rules as for first name matching.

4. *Date of Birth:* There could be no significant difference in birth dates; if available, they had to be within one month of each other.

5. *Social Security Number (SSN):* There could be no strong difference between applicant social security numbers; wherever possible, the last four digits had to match exactly.

6. *Gender:* The gender of the applicant, if available, had to match exactly.

Finally, the last names in the LRP applicant record and the IMPAC II profile record had to match exactly. Additionally, both records had either an SSN or date of birth available for comparison, or at least one of the email addresses, phone numbers, fax numbers, or organizations linked to the IMPAC II profile record had to match that of the applicant.

A3.3. Matching Applicants to MEDLINE Publication Records

The complete set of IMPAC II records for each applicant was used to construct a list of all known email addresses and name aliases for each applicant. This information was then used to retrieve publication records from MEDLINE by matching MEDLINE authors to IMPAC II profile(s) for each applicant based on:

1. An exact match between last names or email addresses (or both).

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[34] RPGs include activity codes starting with R, P, M, S, U (except UC6), G12, D42, DP1, and DP2. K awards were included in this group. All Type 9 grants were excluded. Fellowship and Training grants include activity codes starting with T, F, and G (except G12).

2. The author's first and middle initials could not be in conflict with that of the IMPAC II profile.
3. The author's first name was parsed from a MEDLINE field that combines all portions of a name that are not considered to be the last name. This representation, which is sometimes limited to an initial, could not conflict with the first name from the IMPAC II profile record. An initial that matched the first letter of a first name was considered acceptable.
4. The year of the publication had to be greater than that of the fiscal year of the applicant's LRP application or award year.

A3.4. Manual Error Checking

All results were manually checked to further exclude false positive hits retrieved by the processes described above. We used additional information, such as the applicant's institutional affiliation, scientific research area, and recurring co-authors to definitively verify the applicant as the author listed on a publication.