National Cancer Institute

NCI Career Development (K) Programs

Assessing the Feasibility of Conducting an Evaluation of the NCI Career Development (K) Awards Program

Final Report

Contents

1.0 Introduction and Background

1.1 Purpose and Scope of Feasibility Study

In June 2009, the Center for Cancer Training (CCT) of the National Cancer Institute (NCI) asked Discovery Logic to conduct a feasibility study for evaluating the NCI career development (K) awards program. The K award program at NCI is administered by the extramural branch of CCT, the Cancer Training Branch (CTB). The K program is large and complex, and in fiscal year 2008, supported approximately 448 awards at a cost of $68M. Although the NCI has offered research support through K mechanisms since 1970, there has not been a formal, systematic evaluation of the career outcomes of K grantees and scholars.

The overall objectives of this feasibility study are to:

1) Determine the most appropriate and feasible design for evaluating the outcomes and impact of the NCI K program;
2) Determine the appropriate outcomes of interest as well as the most relevant performance measures for an evaluation of the NCI K program; and
3) Determine appropriate data sources for collection of outcomes-related data.

1.2 NCI K Awards: Goals and Programs

The K awards program aims to provide scientists from a variety of educational backgrounds and at different stages of career development with 3 to 5 years of support for protected time to further develop their cancer research careers, transition to independence, expand their research programs, or mentor junior investigators. Many of the K programs are intended to transition post-doctoral researchers from mentored research to independent investigator positions. Several provide clinical investigators with an opportunity to pursue mentored training in biomedical research, while others provide established/midcareer investigators with an opportunity to transition between research fields (e.g., from engineering to biomedical research), pursue patient-oriented translational research projects or pursue cancer prevention, control, behavioral, and population sciences research while mentoring junior investigators.

The scope of this feasibility study extends to K awards offered by the NCI CCT-Cancer Training Branch. CTB currently offers ten K award mechanisms: K05, K07, K08, K12, K18, K22, K23, K24, K25, and K99. In addition, four CTB-administered K mechanisms are in the process of being phased out (K01) or have been phased out (K04, K06, and K11). Not included in the analysis are the K18 awards, which provide support for career enhancement in stem cell research, and K awards administered by NCI's Diversity Training Branch (DTB), including the K01, K08, K22, and K23. The 13 included K mechanisms were categorized by targeted applicant pool and descriptions are provided below and in **Appendix 7.1**.

1.2.1 NCI K Awards Targeted to Early Career Investigators

- **K01.** The goal of the NCI Howard Temin Award (K01) is to bridge the transition from a mentored research environment to an independent career in basic cancer research. The K01 provides awardees with up to 5 years of support, allowing them the opportunity to gain additional skills and knowledge in human cancer research in a mentored environment culminating in a transition to an independent research/junior faculty position. Beginning in July 2006, NCI began to phase out its K01 program, replacing it with the K99/R00 Howard Temin Pathway to Independence Award mechanism.

- **K04.** The Research Career Development Award (K04) provided up to 5 years of stable support to facilitate the transition from a mentored/supervised research environment to independent research. The NCI awarded K04 grants from 1970 through 1996.

- **K07**. The Cancer Prevention, Control, Behavioral, and Population Sciences Career Development Award (K07) provides 3 to 5 years of support for early-career investigators who have made a commitment to focus their research on cancer prevention, control, behavioral and population sciences. K07 candidates are typically post-doctoral fellows or non-tenured junior faculty, and the award provides an opportunity for specialized didactic study and mentored research to support the transition to independent research careers.

- **K08.** The Mentored Clinical Scientist Development Award (K08) provides up to 5 years of support to individuals with a clinical doctoral degree to provide them with an opportunity to receive mentored training in laboratory-based biomedical or behavioral research. K08 support combines didactic study with methodological and theoretical laboratory training opportunities to develop the skills necessary to pursue independent clinical and/or translational research.

- **K11.** The Physician Scientist Award (K11) provided long-term basic, clinical, or behavioral research training to individuals with clinical science doctorates (MD, DDS, DVM, DO or equivalent) with 2 to 7 years of clinical training at the postdoctoral level, allowing them to transition to independent biomedical investigator positions. The award was administered in two phases: Phase I provided an opportunity for didactic study and laboratory experiences while Phase II allowed recipients to pursue an intensive research project. The NCI awarded K11 grants from 1987 through 1996.

- **K22.** The NCI Transition Career Development Award (K22) provides up to 3 years of "protected time" for newly independent investigators to develop and receive support for their initial cancer research programs, and to facilitate the transition from mentored to independent research. Applicants can be clinicians pursuing basic science careers; clinicians pursuing careers in patient-oriented research; or individuals pursuing careers in cancer prevention, control and populations sciences. The K22 mechanism is unique from other K programs in that applicants are not

required to have a sponsoring institution/junior faculty appointment at the time the application is submitted.

- **K23.** The Mentored Patient-Oriented Research Career Development Award (K23) provides up to 5 years of support for combined didactic study and mentored research, allowing awardees to acquire the methodological and theoretical research skills needed to pursue independent clinical and patient-oriented research.

- **K99/R00.** The Howard Temin Pathway to Independence Award (K99/R00) is intended to facilitate the receipt of an R01 award earlier in an investigator's research career. Support is administered in two phases: 1 to 2 years of mentored support for postdoctoral research (K99) followed by up to 3 years of independent support (R00), contingent on securing an independent research position. During the second phase, awardees are expected to successfully compete for independent R01 support.

1.2.2 NCI K Awards Targeted to Mid-Career Investigators

- **K05.** The Established Investigator Award in Cancer Prevention and Control (K05) provides established investigators "protected time" to conduct research in cancer prevention, control, behavioral and population sciences and to serve as a mentor to early career investigators in these fields. Awardees receive up to 5 years of support, and have the option to renew for an additional 5 year period.

- **K06.** The Research Career Award (K06) provided support to established investigators of high competence for the duration of their careers as long as they successfully obtained peer-reviewed research grant support. This mechanism was phased out and replaced with other award mechanisms (Outstanding Investigator and MERITAwards).

- **K24.** The Mid-Career Investigator Award in Patient-Oriented Research Award (K24) provides established, mid-career investigators with "protected time" (up to 5 years) to conduct patient-oriented/human subjects research and to serve as mentors to individuals beginning their clinical research careers.

- **K25.** The Mentored Quantitative Research Career Development Award (K25) provides 3 to 5 years of career development support to investigators with backgrounds in quantitative and engineering sciences (e.g., outside classical biomedical research fields) to pursue basic or clinical research in the biomedical or behavioral sciences. Applicants may range from postdoctoral fellows to senior faculty members.

1.2.3 NCI K Institutional Training Awards

- **K12.** The Paul Calabresi Award for Clinical Oncology (K12) is a multi- and trans-disciplinary institutional training award that supports the research career development of clinicians and basic science researchers to pursue patient-oriented research, translational research, and clinical studies focused on the development of cancer therapeutics. The K12 is awarded at the institutional level, rather than to an individual, and provides up to 5 years of support for clinical and research scholars.

1.2.4 NCI K Awards by Scientific Area
Several of the NCI K mechanisms provide funding to encourage investigators to pursue specific areas of cancer research. **Table 1** displays the NCI K mechanisms grouped by targeted research area.

Cancer Prevention & Control	K05, K07, K22, K25
Translational/Clinical	K08, K12, K23, K24
Basic Sciences	K01, K04, K08, K11, K22, K25, K99
Trans-disciplinary	K22, K25

Table 1. NCI K mechanisms categorized by scientific area.

1.2.5 NCI K Mechanisms Included in Study
For the purposes of this feasibility study, we focused on three mechanisms—K07, K12, and K22. This allowed for exploration of programs targeted to distinct audiences, namely basic researchers (K07), clinicians (K22), and an institutional award with principal investigators (PIs) and scholars (K12). What we learn from this targeted study may be applied to prioritize mechanisms to be included in a more comprehensive evaluation of all NCI K mechanisms.

Across all K mechanisms, the NCI CTB has received a total of 6,035 applications and made 1,788 awards[1]. The K07 mechanism, which has been awarded by NCI since 1980 and is the longest running program explored in detail in this feasibility analysis, has received 831 applications and made 278 awards through FY2008[2]. The K22 mechanism has been awarded by NCI since 1998, and has received 322 applications, of which 73 were awarded[3]. The K12 mechanism has been awarded by NCI since 1992. As previously noted, the K12 mechanism is an institutional award, therefore, while 114 applications yielded 44 unique awards, these awards resulted in the training of approximately 350 scholars.

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[1] The 6,035 figure represents the total number of applications to all NCI CTB K programs. Individual applicants may have submitted multiple applications to one or more NCI K programs, and each application is counted in this overall total. The 1,788 figure represents the total number of unique awards across all NCI K programs.

[2] The 831 figure represents the total number of applications to the NCI CTB K07 program. If an individual submitted applications in multiple years, each application is counted separately. The 278 figure represents the total number of unique NCI K07 awards.

[3] The 322 figure represents the total number of applications to the NCI CTB K22 program. If an individual submitted applications in multiple years, each application is counted separately. The 73 figure represents the total number of unique NCI K22 awards.

2.0 Key Research Questions

2.1 What are the desired indicators and metrics?

A logic model was developed to identify, define and categorize critical components to be measured and analyzed in the current feasibility study as well as areas that could be explored in a future larger-scale analysis. The logic model is broken down into four categories:

- **INPUTS** include the features that define applicants to the NCI K programs, as well as the features of the individual mechanisms.
- **CONTEXT** refers to specific features of the past and present environment in which the program participants are functioning.
- **OUTCOMES** include features that may be a direct result of participation in an NCI K program.
- **IMPACT** tracks the systemic effects of program participation at the individual and institutional level.
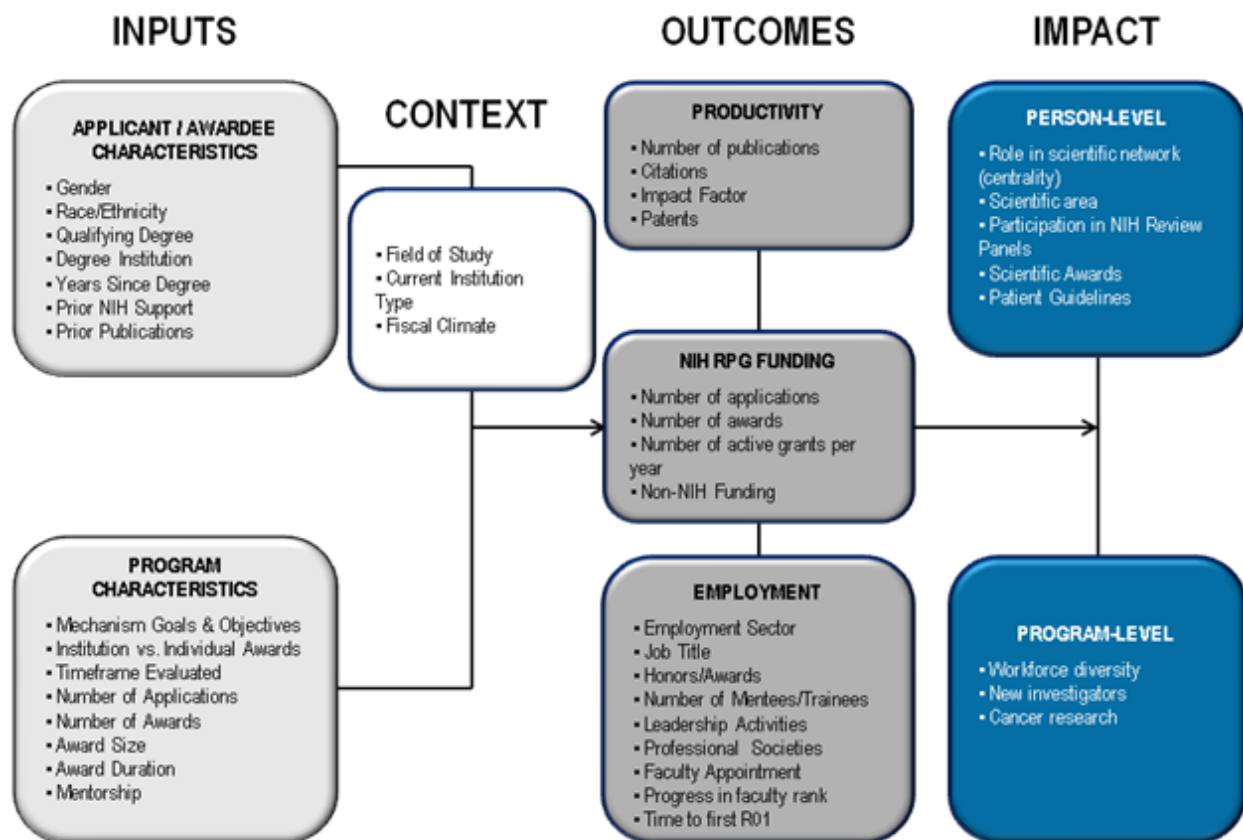

Figure 1. Logic model for evaluation of NCI K awards program.

This logic model was used to develop a set of study questions to be contemplated in the feasibility analysis, listed below.

1) **What are the characteristics and demographics of NCI K award program applicants and awardees?**
2) **What are the performance and post-award outcomes of NCI K awardees?**
3) **To what extent has the NCI K award program met its goals?**
4) **What impact does receiving an NCI K award have on career outcomes?**
5) **How do NCI K awardees compare to unsuccessful applicants or participants in similar career development programs?**

2.2 What data sources are available?

For this feasibility analysis, we chose to focus on information available through extant data sources. The NIH grants database, IMPAC II, was the primary data source through which information about NCI K applicants and awardees was obtained, including basic demographic information and data regarding prior and subsequent NIH grant applications.

We also explored our ability to find career outcome information on NCI K awardees in other NIH and non-NIH databases. The NIH Employee Directory (NED) database was used to determine the number of NCI K applicants currently employed by the NIH as a federal employee or contractor. The Enumeration database was developed by Discovery Logic through a contract with the NIH Office of Extramural Research and includes key personnel supported by NIH extramural grants from FY2005-2007 (McGarvey, et al. 2008); this dataset was used for the current analysis to determine whether NCI K awardees were recorded as Key Personnel or otherwise supported by NIH funding. The non-NIH databases included the Department of Defense (DOD) DTICRS database, MEDLINE, National Science Foundation (NSF) FastLane database, Department of Energy (DOE) grants, the National Science Foundation Doctoral Record File (DRF), and the American Association of Medical Colleges (AAMC) Faculty Record database (**Appendix 7.2**). Manual searches of the professional networking website LinkedIn were conducted to assess our ability to locate K awardees with no future funding records in IMPAC II and to determine career outcomes of these individuals.

Additional sources, such as the American Medical Association's (AMA) Physician Masterfile, as well as databases or records of Foundation grants or awards, such as the American Cancer Society, International Cancer Research Portfolio, Breast Cancer Research Foundation, the Avon Foundation, and Research Crossroads, were explored, but not matched to the NCI K awardee lists at this time.

2.3 What data may be used to address study questions?

A major component of this feasibility study was to determine data sources for each set of questions within the study logic model. **Appendix 7.2** provides a list of study variables and relevant data sources. Since this is an evaluation of an NIH awards program, much of the input information can be obtained from the NIH IMPAC II database. However, demographic characteristics could be supplemented with additional sources, such as the American Association of Medical College's (AAMC) Faculty Roster and the National Science Foundation (NSF) Doctoral Record File (DRF) database. The AAMC Faculty Roster serves as a mechanism through which information on the academic, educational, and demographic

backgrounds of faculty at U.S. medical schools can be collected and disseminated[4]. The DRF database contains data on all earned doctorates[5], including recipient name, gender, race/ethnicity, and doctoral field, granted by U.S. universities from 1920 through 2006[6]. In particular, use of the AAMC Faculty Roster database would allow for a more refined analysis of applicant and awardee race and ethnicity, as it has a more detailed breakdown of racial and ethnic groups than available through IMPAC II or DRF. Use of NSF and AAMC data sources could also enhance the evaluation of programs in which funds are granted to an institutional PI and used to support Scholars (K12), or the award PI serves as a mentor (K05, K24). In many cases, scholars do not have IMPAC II records but do appear in the DRF or AAMC databases.

Evaluation of outcomes will require a diverse range of data sources, such as MEDLINE and Thomson ISI Web of Science to explore post-award publications and the USPTO Issued Patents database to track patents. A large component of the outcomes evaluation is to assess research funding post-K award. In addition to determining subsequent funding from NIH using IMPAC II, other federal databases can be explored, including the Department of Defense (DoD) DTIC database, the National Science Foundation (NSF) FastLane database, and the Department of Energy (DOE) grants database. Several non-profit foundations provide substantial grants to cancer researchers, and their data could also be used to determine post-K award funding. These foundations include the Avon Foundation, Breast Cancer Research Foundation, and the American Cancer Society. The International Cancer Research Portfolio (ICRP) and ResearchCrossroads also compile and report funding information from several additional foundations.

It is expected that many K awardees may have chosen not to pursue a career in academia. While a bit more challenging to track, it is not impossible to assess the outcomes of these individuals. For those awardees that choose to practice medicine, the American Medical Association (AMA) Physician Masterfile can serve as a data source. In previous projects, the professional networking website LinkedIn has served as a useful method of identifying individuals who have pursued careers in industry.

Based on our preliminary evaluation of existing data sources, we do not believe that additional qualitative and/or quantitative instruments or tools, such as surveys, need to be developed to conduct an effective evaluation. Surveys may provide additional information on the qualitative aspects of training, such as a participant's rating of the extent to which the K training experience affected subsequent career decisions.   Such information may be most useful for those awardees who did not continue on in research, however, due to limitations with the NIH data, in particular the quality of data for K scholars, there are few if any options to locate these individuals. For instance, of 109 NCI K12 Scholars with no IMPAC II records, we were unable to locate additional information for 43 (39.4%) using the Google search engine or LinkedIn website. Instead of surveys, resources may instead be put into

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[4] More information regarding the AAMC Faculty Roster is located at: http://www.aamc.org/data/facultyroster/. Accessed on October 26, 2009.

[5] The DRF defines the following degrees as doctorates: Ph.D., Sc.D., Ed.D., Doctor of Arts, etc. Professional doctorates such as M.D., D.D.S., and D.V.M. are not included.

[6] More information regarding the NSF Survey of Earned Doctorates, which is used to populate the DRF, can be found at: http://www.nsf.gov/statistics/srvydoctorates/. Accessed on October 26, 2009.

enhancing data collection on scholars, including first name, last name, middle initial/name, street and email address. Future evaluations could use these enhanced data to examine outcomes for trainees.

3.0 Summary of the NCI K Program

To understand who is applying to the NCI K award program, we analyzed several demographic variables using data from IMPAC II: gender, self-identified race/ethnicity, qualifying degree, and years since qualifying degree. We conducted a general analysis of all NCI K awards, but evaluated the three targeted mechanisms (K07, K12, and K22) by fiscal year.

Across all NCI CTB K mechanisms, there were a total of 6,035 applications, of which 1,788 were awarded[7]. Three mechanisms (K04, K07, and K08) have been receiving applications for more than 25 years. Most programs have approximately 10 years of applicant data, with the exception of the relatively new K99 award, which was introduced in FY2007. **Table 2** provides a summary of all K mechanisms.

Mechanism	Years Offered	Total Applications[8]	Total Awards[9]	Overall Success Rate
K01	1997 - 2007	624	155	24.8%
K04	1970 - 1996	1,320	357	27.1%
K05	2001 - 2008	77	31	40.3%
K07	1980 - 2008	831	278	33.5%
K08	1984 - 2008	1,648	528	32.0%
K11	1987 - 1996	213	88	41.3%
K12	1992 - 2008	114	44	38.6%
K22	1998 - 2008	322	73	22.7%
K23	1999 - 2008	367	101	27.5%
K24	1999 - 2008	161	53	32.9%
K25	2000 - 2008	87	25	28.7%
K99	2007 - 2008	271	55	20.3%
Overall	**1970 - 2008**	**6,035**	**1,788**	**27.9%**

Table 2. General statistics of NCI K mechanisms evaluated in feasibility analysis.

3.1 Applicant and Awardee Gender

The National Science Foundation reports that in recent years, men received 52.5% of biological sciences PhD degrees while women received 47.5% (National Science Foundation 2008). The American Association of Medical Colleges reports that 55.8% of MD degrees were earned by men and 44.2% by women (Association for American Medical Colleges 2008).

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[7] Individual applicants may have submitted multiple applications to one or more NCI K programs; each application is counted in the total. Total awarded represents the number of unique awards across all NCI K programs.
[8] Figures in the "Total Applications" column represent all applications to a K program, and may include multiple applications by an individual.
[9] Figures in the "Total Awards" column represent the number of unique awards made for an NCI K program.

To analyze the gender distribution across the NCI K mechanisms, we determined the number of men and women who applied to NCI CTB K mechanisms. The majority of applicants to and awardees of NCI K mechanisms were male, as shown in **Figure 2**.
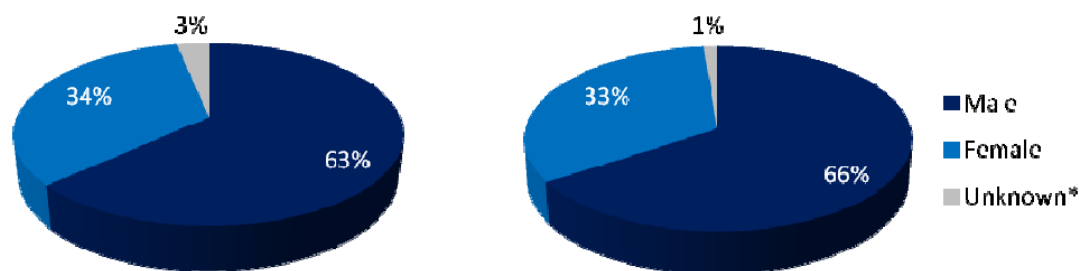

Figure 2. Distribution of male and female NCI K program applicants (*left*) and awardees (*right*).
*NOTE: Unknown category refers to applicants/awardees who did not specify gender on their applications.

Next, we analyzed the gender distribution for applicants and awardees for the three K mechanisms—K07, K12, and K22—explored in greater detail for this feasibility study. As shown in **Figure 3**, the K07 mechanism attracts a majority of female applicants, in turn resulting in a majority of female awardees. The K22 mechanism has a more even distribution of male and female applicants; however, there is a slight majority of male applicants and awardees. The K12 mechanism presents a slightly different scenario in that established principal investigators (PIs) apply for the grant, and use the funds to support scholars. Therefore, the K12 applicant data only represents the PIs, the majority of whom are male. The awardee data shows the gender distribution for both PIs and Scholars. An overwhelming majority of the K12 Awardees (PIs) was male, but the data for the K12 Scholars are less clear due to data quality issues (**Figure 4**).
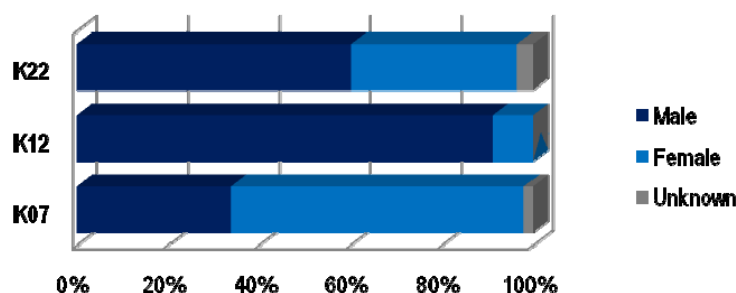

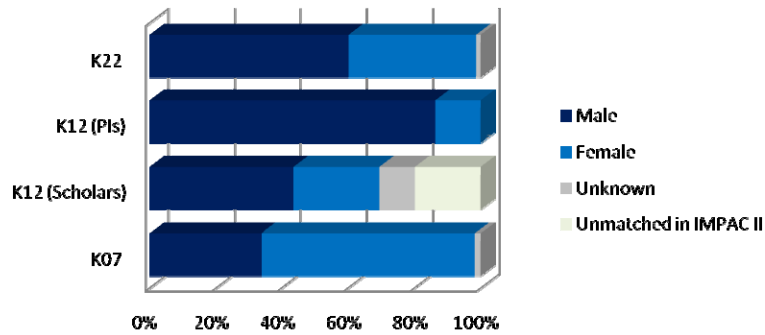**Figure 3. Gender distribution of applicants for targeted NCI K mechanisms.**

Figure 4. Gender distribution of awardees for targeted NCI K mechanisms.

To learn more about the gender distribution for each of the targeted NCI K mechanisms, we examined gender distribution of applicants and awardees annually.

The K07 is the longest-running mechanism of those explored in detail, with the first applications and awards appearing in IMPAC II in 1980. As shown in more detail in **Figure 5**, the K07 mechanism attracts more female than male applicants. Due to the low numbers of applicants in the early years of this program, for this feasibility analysis we chose to combine the early years into 5 year cohorts. There were also several years in which there were no recorded applicants.
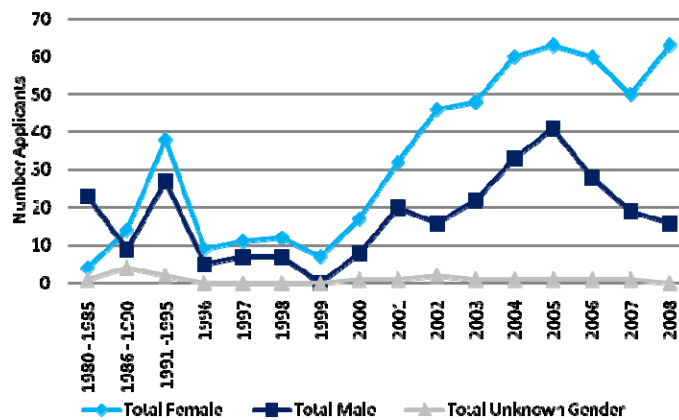

Figure 5. Gender of K07 applicants, by fiscal year.

When looking at the gender of K07 awardees by fiscal year, in most years, female awardees outnumbered males (**Figure 6**). This is consistent with the applicant data, in which there was a clear majority of female K07 applicants.
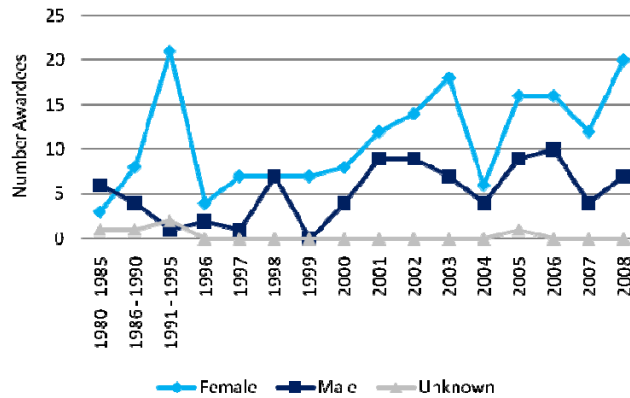
Figure 6. Gender of K07 awardees, by fiscal year.

The NCI K12 mechanism is awarded to established PIs to provide support to Scholars for clinical laboratory training opportunities. IMPAC II records only provide information on the K12 PIs. All K12 Scholar data is collected by the PI Institution, and to date does not include any demographic information. This feasibility analysis examined data from the first NCI K12 award in FY1992 through FY2008, a total of 114 applications. There were no applications in FY1994-1996 or FY1999. As shown in **Figure 7**, the majority of K12 applicants (PIs) were male.
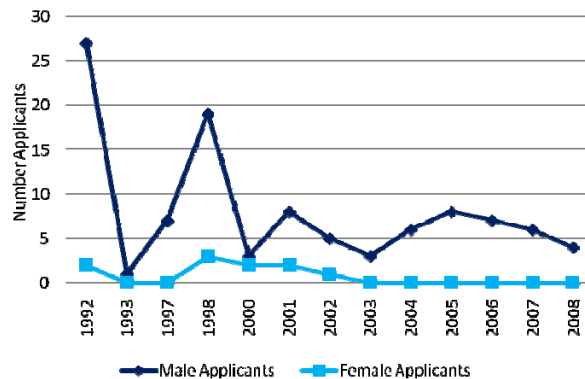

Figure 7. Gender of K12 applicants (PIs), by fiscal year.

An overwhelming majority of the K12 Awardees (PIs) were male however, the overall awardee numbers were very small, with many years having fewer than 3 awardees (**Figure 8**).
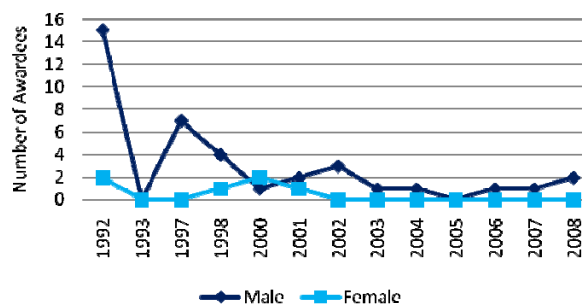

Figure 8. Gender of K12 awardees (PIs), by fiscal year.

Gender trends among the K12 Scholars are less clear (**Figure 9**) since 35% of the K12 Scholar pool was either unmatched to an IMPAC II record or did not report gender data. For those Scholars with gender data, about 40% were male, and approximately 25% were female.
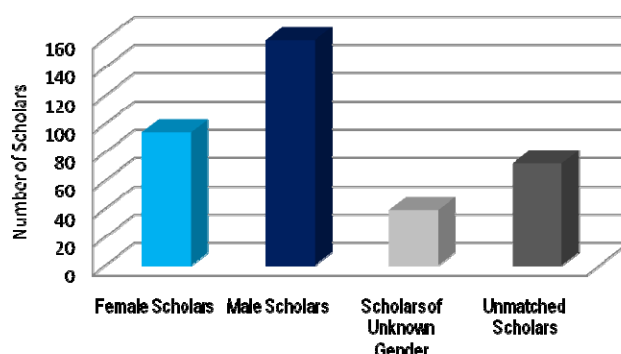

Figure 9. Gender distribution of K12 Scholars.
NOTE: The category "Unmatched Scholars" indicates individuals not matched to an IMPAC II record.

The first NCI K22 applications were recorded in FY1998. There were no applications in FY1999, but applications continued annually from FY2000-2008. Similar to the K07 data, the numbers of K22 applicants took several years to stabilize, and more consistent trends appear after FY2001. In general, the data indicate that the majority of K22 applicants are male (**Figure 10**). Overall, the gender distribution of male to female applicants is more balanced for the K22 mechanism than for other K mechanisms.
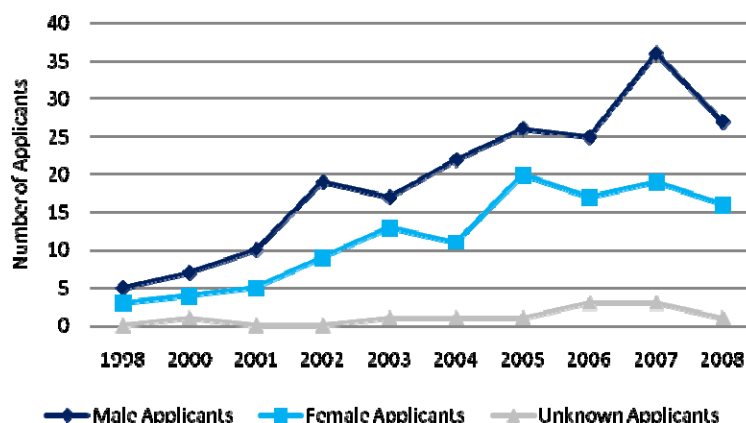
Figure 10. Gender of K22 applicants, by fiscal year

Overall, the gender distribution for the K22 awardees shows a somewhat even distribution of women and men. The distribution by fiscal year (**Figure 11**) shows two "spikes" indicating an increase of male awardees coupled with a decrease in female awardees (FY2001-2002 and FY 2007-2008). The period between FY2003 through 2006 shows a more even distribution of male and female awardees, and there are two years, FY2005 and FY2006, in which female awardees outnumbered males.

Figure 11. Gender of K22 awardees, by fiscal year.

3.2 Distribution of Race and Ethnicity in NCI K Applicants and Awardees
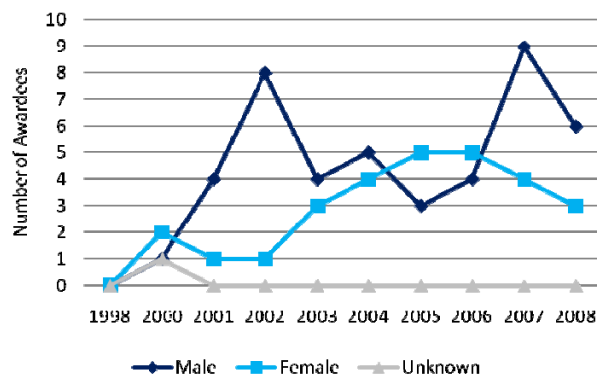
The National Science Foundation reported that during the time period of 1999 through 2006, Hispanics received 4.5% of biological sciences PhD degrees, Blacks 3.2%, Asians 12.8%, Native Americans 0.3%, and Whites 76.2% (National Science Foundation 2008).

Data on race and ethnicity for this feasibility analysis were obtained from IMPAC II, and included 5 categories: White, Asian, Black, Hispanic, and Native American.[10] Two additional categories, other and unknown, captured individuals who listed more than one race or races not included in these 5 categories and individuals for whom racial/ethnic information was not reported, respectively. **Figure 12** shows applicants by race/ethnicity.
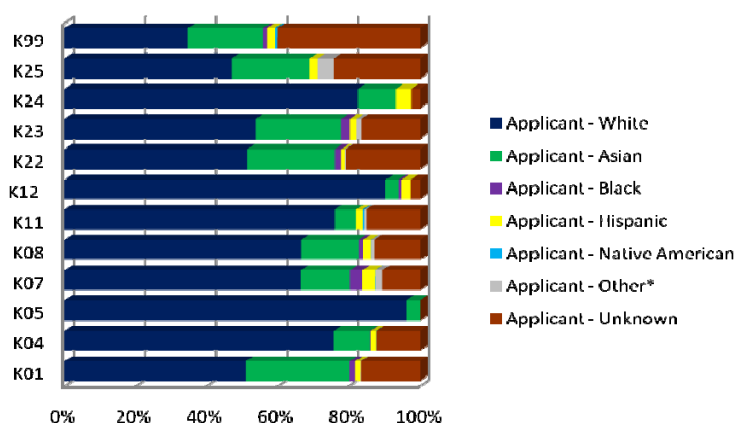
Figure 12. Race and ethnicity of applicants across NCI K mechanisms.

Across all K mechanisms, Whites comprised 65% of applicants, Asians 16%, unknown 14%, Hispanics 2%, Blacks 1%, and Native Americans and other less than 1%. For the K25 and K99, the "Unknown" category consumed a prominent proportion of applicants, which may be largely attributable to the fact that only

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[10] Note that this feasibility analysis focused on CTB K awards and specifically excluded applications and awards with a Diversity Training Branch PCC (MB).

IMPAC II data was used for collection of race/ethnicity data, and in recent years provision of gender and race/ethnicity by NIH grant applicants has been optional. Use of additional data sources to augment the IMPAC II data records, such as the AAMC Faculty database or the NSF DRF could help reduce the proportion of applicants and awardees in the unknown race/ethnicity category. To test this, we analyzed data coverage using the K22 awardee pool. Of 73 awardees, 64 were matched to DRF, AAMC or both, while 9 awardees were not matched to these additional sources (**Table 3**).

AAMC	PI Count	Have Race/Ethnicity Data
Matched	50	46
Not Matched	23	0*
DRF	**PI Count**	**Have Race/Ethnicity Data**
Matched	41	40
Not Matched	32	0**

Table 3. Results of matching K22 awardees to AAMC and DRF data sources to obtain additional data regarding race and ethnicity. NOTE: Of the 73 K22 awardees, 64 were matched to either DRF, AAMC, or both, while 9 awardees (~12%) were not matched to either DRF or AAMC. * Of the 23 awardees not matched to AAMC, 14 were matched to DRF, and 13 had race/ethnicity data. ** Of the 32 awardees not matched to DRF, 23 were matched to AAMC, and 21 had race/ethnicity data.

Across NCI K mechanisms, the distribution of racial and ethnic categories among K awardees generally mirrored the demographics of the applicant pools and the recent doctoral degree population. Overall, K awardees are 72% White, 15% Asian, 8.4% Unknown, 2% Hispanic, 1% Black, and less than 1% Native American and Other (**Figure 13**).
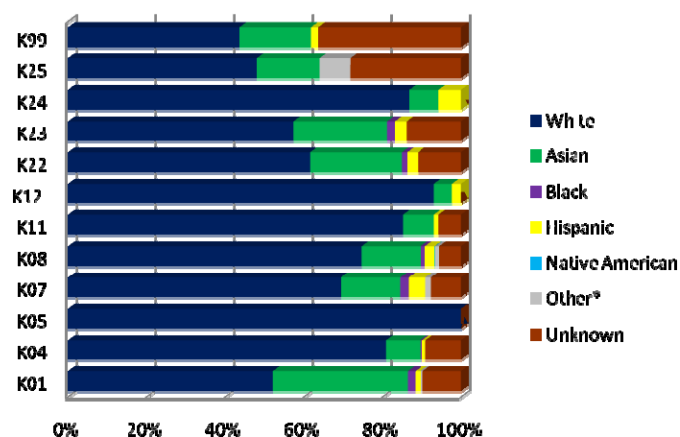

Figure 13. Race and ethnicity of awardees across NCI K mechanisms.

To learn more about the racial/ethnic distribution of applicants for each of the targeted NCI K mechanisms, we examined yearly distribution for each of the K07, K12, and K22 mechanisms.

For K07 applicants, the data presented in **Figure 14** indicate that the majority of applicants are White, with Asians being the second-most represented. There is also a fairly large representation of individuals in the Unknown category, particularly in the earlier years of data collection (e.g., 1983 and 1989). A clearer picture of racial/ethnic demographics could be better achieved by populating racial/ethnic information using AAMC and NSF-DRF databases to supplement the information obtained from IMPAC II. Combining 1980-1995 data into 3-5 year bins would also assist in visualization of trends.
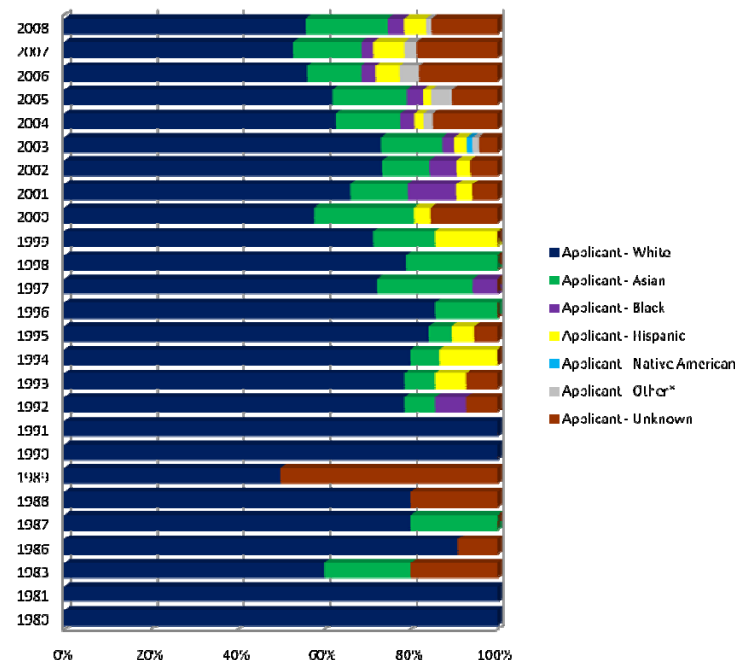
Figure 14. Race and ethnicity of K07 applicants, by fiscal year.

The majority of K07 awardees for each year are White, however, we do see an increase in the proportional representation of Asians compared to the applicant pool (compare **Figure 15** with **Figure 14**). While there are proportionately fewer awardees of unknown or unreported race or ethnicity, these groups still comprise a large portion of the awardee pool, particularly in FY1983, FY1989, and FY2006-2008.
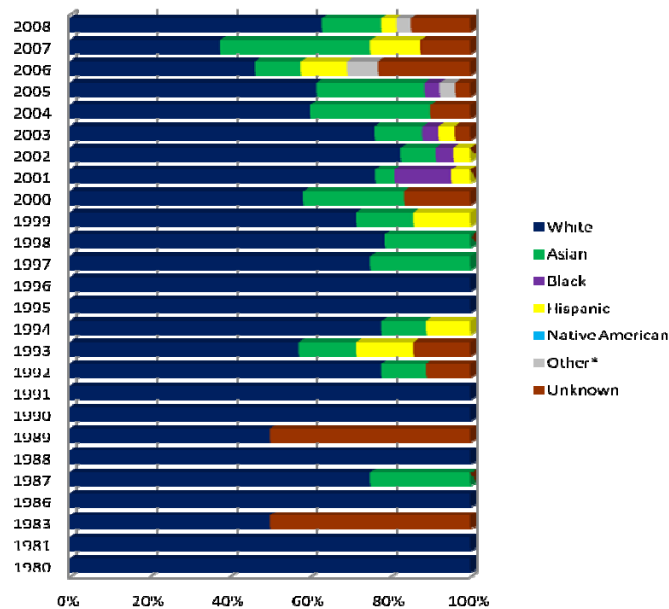
Figure 15. Race and ethnicity K07 awardees, by fiscal year.

Figure 16 shows the racial/ethnic distribution of K12 applicants (PIs), the overwhelming majority of whom are White.
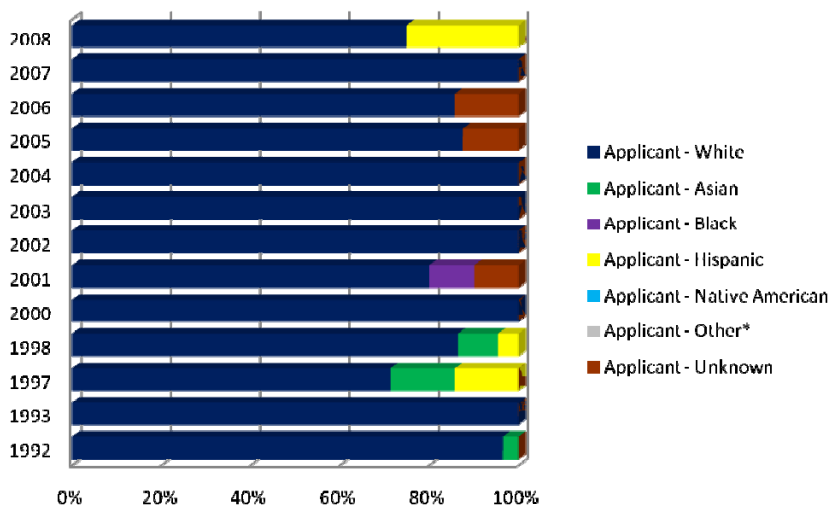
Figure 16. Race and ethnicity of K12 applicants (PIs), by fiscal year.

As previously noted, K12 applicants have been predominantly White. This is reflected in the racial/ethnic distribution for awardees (PIs) where there is minimal non-White representation (**Figure 17**). When we examined the race and ethnicity of K12 Scholars matched to IMPAC II (**Figure 18**), the trends matched those generally seen across K mechanisms—the majority of Scholars self-identified as White, with the second largest group being Asian. This information is complicated by the proportion of Scholars not reporting race as well as the large proportion (>20%) of Scholars not matched to IMPAC II.
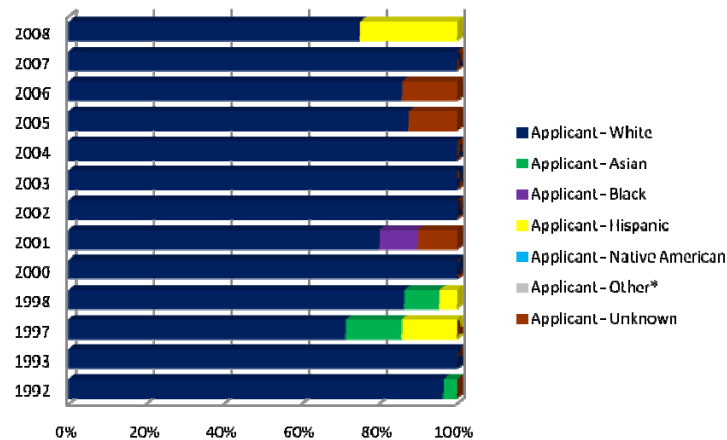
Figure 17. Race and ethnicity of K12 awardees (PIs), by fiscal year.
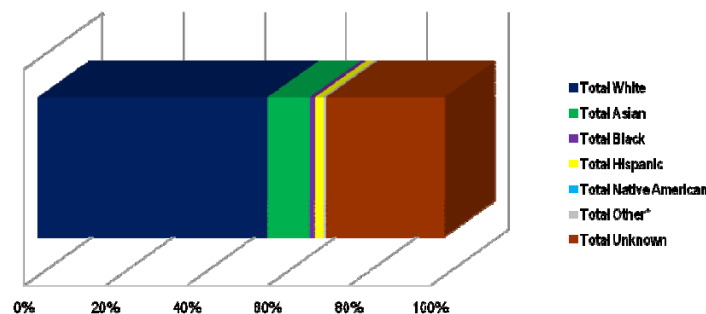
Figure 18. Race and ethnicity of K12 Scholars.

The distribution of racial and ethnic categories of K22 applicants is shown in **Figure 19** and awardees in **Figure 20.** While the majority of applicants and awardees self-identified as White, the proportion of Asian applicants and awardees is much higher than for the K07 or K12 mechanisms. There is also a much larger proportion—over 20% from FY2004 through FY2008—of applicants and awardees of Unknown race and ethnicity. This results in an unclear picture of the race and ethnicity of K22 applicants and awardees.
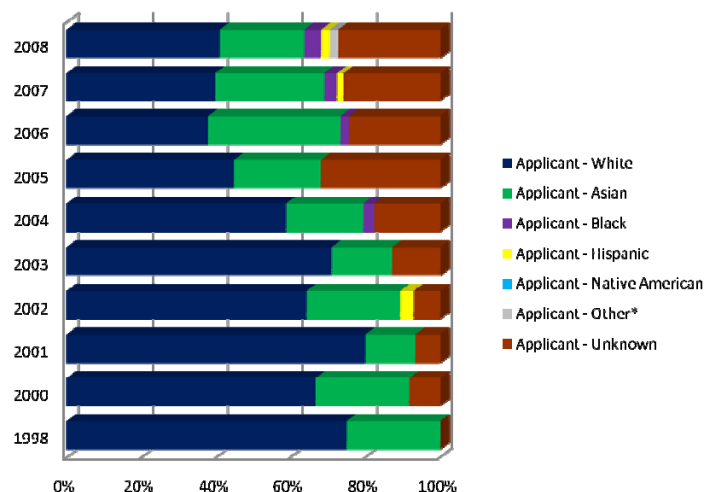
Figure 19. Race and ethnicity of K22 applicants, by fiscal year.
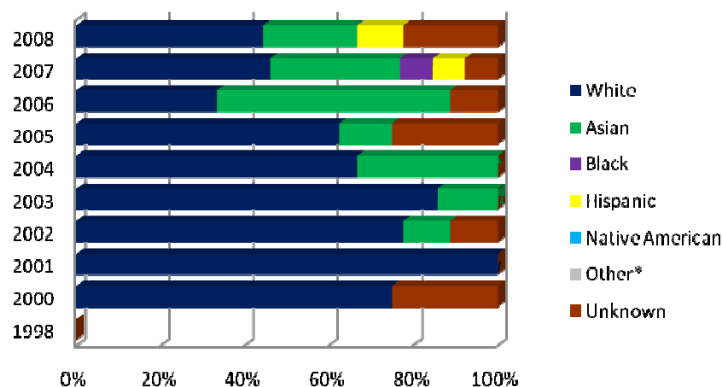
Figure 20. Race and ethnicity of K22 awardees, by fiscal year.
Note: There were 0 awardees in FY1998

3.3 Qualifying Degrees of NCI K Applicants and Awardees

The next variable explored was the qualifying degree of applicants to NCI K mechanisms. All K mechanisms require applicants to have a doctoral level degree, and certain mechanisms are targeted to individuals with specific doctoral degrees. IMPAC II data were used to determine the qualifying degrees of applicants and awardees. Data for all NCI K mechanisms are shown in **Figure 21**.
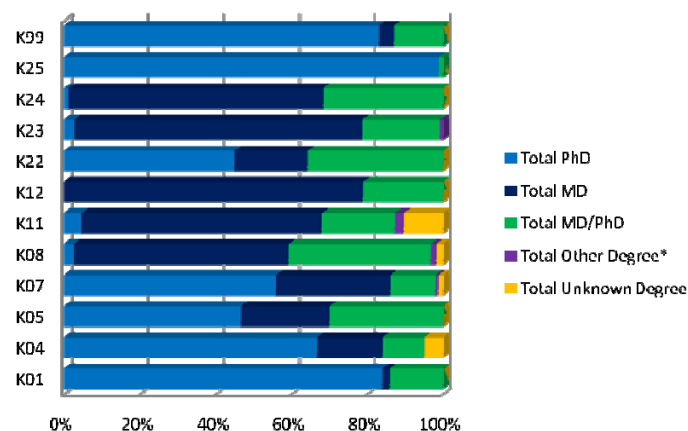
Figure 21. Qualifying degrees of NCI K applicants. NOTE: The category "Other Degree" includes: BH, DDS, DH, DMD, DPharm, DVM, JD, LLD, MMED, ND, OD, PharmD, PHM, PsyD, and RN.

The qualifying degrees of NCI K awardees mirrored the proportions seen in the applicant pool with the exception of decreased representation of "unknown" degrees for the K04 and K11 awardees (**Figure 22**).
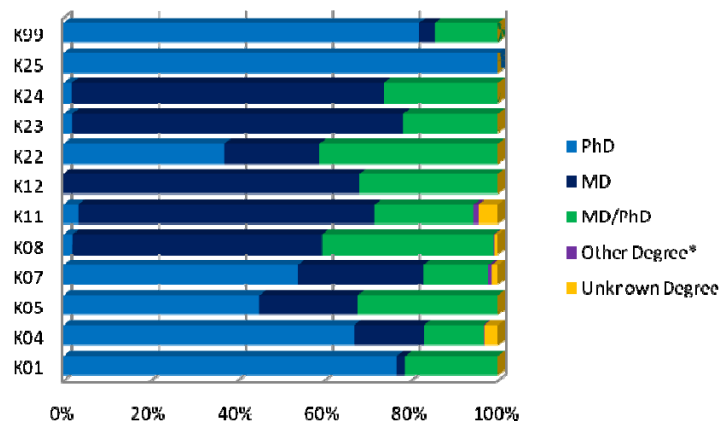
Figure 22. Qualifying degrees of NCI K awardees.

There are clear trends in the preferred qualifying degree of applicants and awardees for certain K mechanisms. For example, the K01, K04, K25, and K99 show a clear preference for individuals with a PhD. Several programs, namely the K08, K11, K12, K23, and K24, are specifically targeted to individuals with a medical/clinical doctorate. The K11 and K04 mechanisms have approximately 10% of applicants for which the qualifying degree is unknown. These data could be improved by supplementing IMPAC II data with degree information from the AAMC and DRF datasets.

To learn more about the distribution of qualifying degrees of applicants and awardees for each of the targeted NCI K mechanisms, we examined yearly distribution for each of the K07, K12, and K22 mechanisms. As discussed previously, the K07 mechanism is targeted to postdoctoral fellows or non-tenured junior faculty, and thus it is not surprising that the majority of applicants have PhDs. MDs are the second-most represented degree type, followed by MD/PhD applicants. There is nominal

representation of applicants with "other" degrees (medical doctorate equivalent or clinical doctorates) (**Figure 23**). Although there were more MD than MD/PhD applicants, MD/PhDs seem to have a greater success rate, as seen in **Figure 24**.
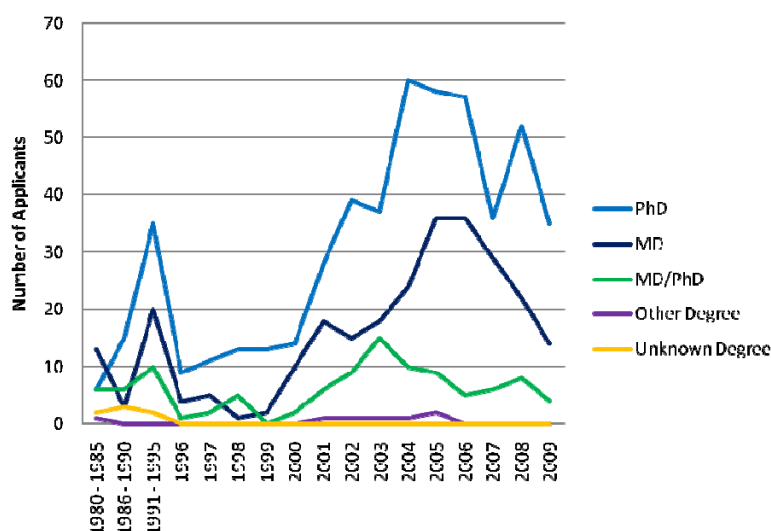
Figure 23. Qualifying degrees of K07 applicants, by fiscal year. NOTE: Data from 1980 through 1995 were binned into 5 year cohorts. The category "Other Degree" includes: BH, DDS, DH, DMD, DPharm, DVM, JD, LLD, MMED, ND, OD, PharmD, PHM, PsyD, and RN.
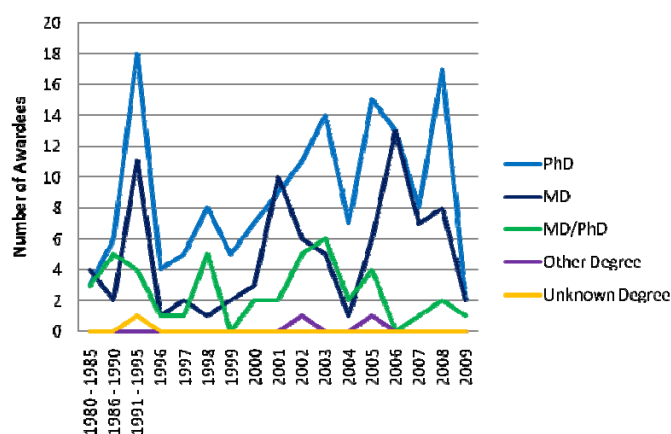
Figure 24. Qualifying degrees of K07 awardees, by fiscal year.

K12 applicant (PI) data are presented in **Figure 25**. The majority of applicants to the K12 mechanism held MD degrees, while none of the K12 applicants held PhD degrees.
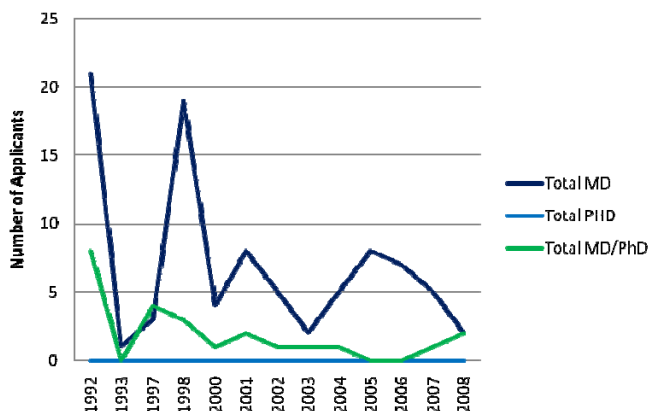
Figure 25. Qualifying degrees of K12 applicants (PIs), by fiscal year.

The qualifying degrees of K12 awardees (PIs) mirrored the trends seen in the applicant pool. All of the K12 awardees held either MDs or MD/PhDs (**Figure 26**). K12 scholars presented slightly different distributions (**Figure 27**), with the majority holding an MD, but also fair representation of PhDs and MD/PhDs. A few of the scholars held "Other" degrees, a category that includes clinical doctorates such as DDS, DVM, PharmD, PsyD, as well as others, and two scholars held "Clinical Masters" degrees, which include clinical or public health specialty Masters degrees. There was a fairly large proportion of K12 scholars for whom degree information was unknown or unreported in IMPAC II.
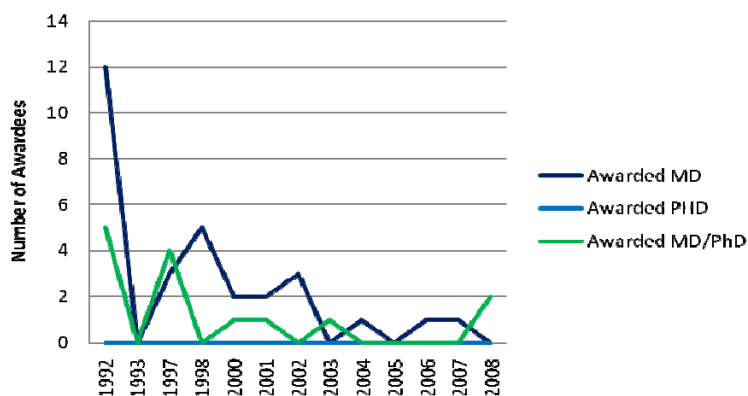
Figure 26. Qualifying degrees of K12 awardees (PIs), by fiscal year.
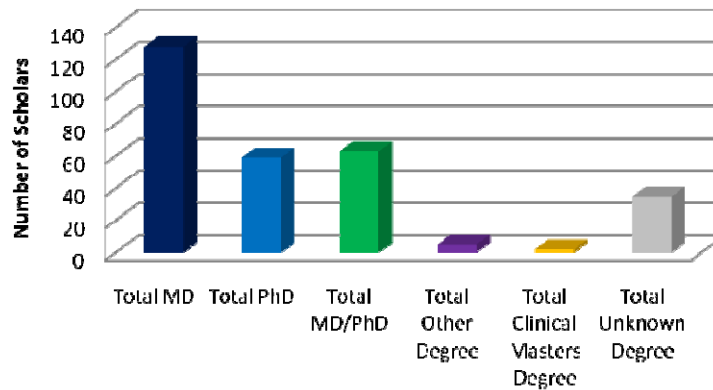
Figure 27. **Qualifying degree of K12 scholars matched to IMPAC II.** NOTE: "Other" degree category includes BH, DDS, DH, DMD, DPharm, DVM, JD, LLD, MMED, ND, OD, PharmD, PHM, PsyD, and RN. The "Clinical Masters" degree category includes clinical or public health specialty Masters degrees such as MHS, MPH, MSCE, MSCI, and MSCR.

Finally, the majority of applicants to the K22 mechanism either held PhD or MD/PhD degrees (**Figure 28**). This finding is in line with the goals of the K22 mechanism, which is targeted to individuals who are seeking to establish independent research careers as part of their faculty appointments.
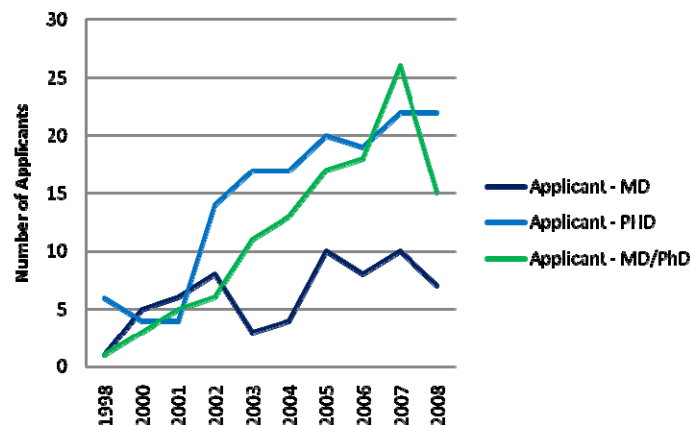
Figure 28. Qualifying degrees of K22 applicants, by fiscal year.

The qualifying degrees of K22 awardees indicated some differences from the applicant pool (**Figure 29**). Over 50% of the K22 applicant pool held PhDs, and one-third held MDs. The K22 awardees showed a fairly even balance between PhDs and MD/PhDs. In FY2000-2001, MD applicants and awardees exceeded both PhD and MD/PhD applicants and awardees.
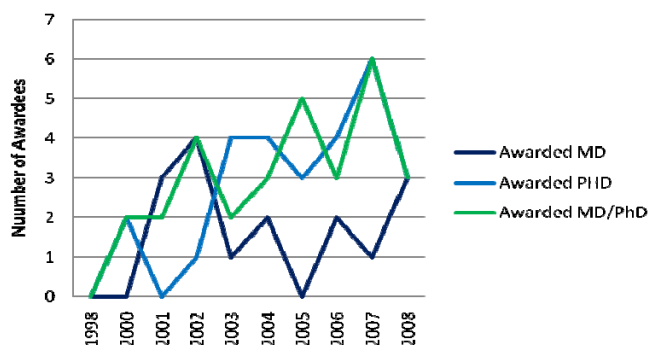
Figure 29. Qualifying degrees of K22 awardees, by fiscal year.

3.4 Average Years since Degree of NCI K Applicants and Awardees

As discussed in Section 1.2, some K mechanisms may be targeted to investigators early in their careers while others may be targeted to mid-career researchers or clinicians. An analysis of average years since degree (YSD) allows for mapping of trends within a particular mechanism. For instance, **Figure 30** shows that three mechanisms—K05, K12, and K24—seem to attract investigators more than 15 years post-degree. Other programs, such as the K07, K25, and K99, show a preference for investigators earlier in their careers.
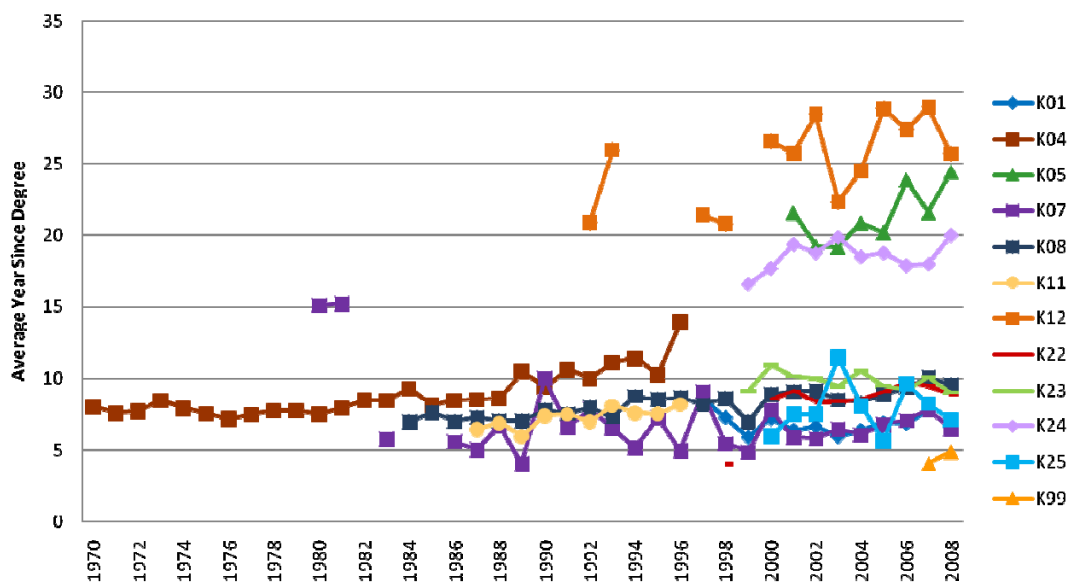
Figure 30. Average years since degree for applicants to all NCI K mechanisms, by fiscal year.

Analysis of average YSD for applicants to the three targeted K mechanisms—K07, K12, and K22—shows clear trends for the applicant pool for each (**Figure 31**). The K07 applicants are typically the earliest since degree conferral, usually around 5 – 7 years. The K22 applicants are typically 8 – 10 years post-degree. There is more variance in the K12 (PIs), however, they are always at least 20 years post-degree.
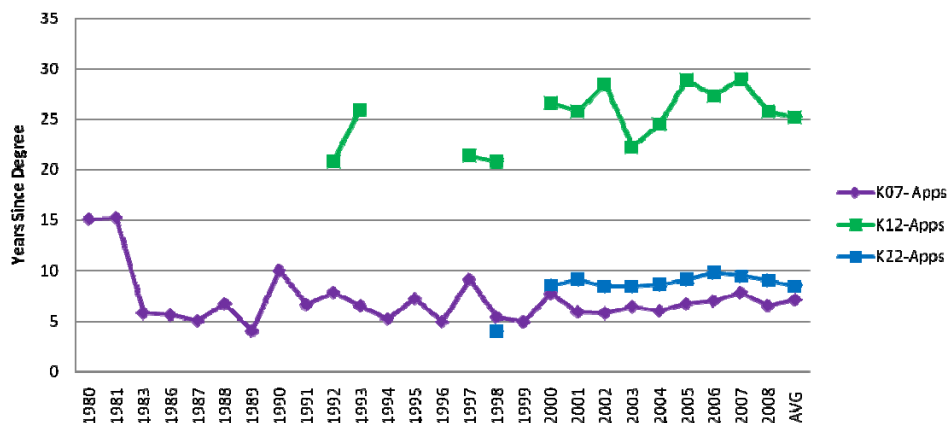
Figure 31. Average years since degree for applicants to targeted NCI K mechanisms, by fiscal year

We further explored the average YSD for the targeted K mechanisms to determine whether there was a trend for awardees to receive the grant sooner after degree conferral (K07 and K22) or later for mentors (K12) (**Figure 32**). The trends for awardees generally mimicked those of the applicants, with a few notable exceptions:

- The average YSD for the K07 awardees in FY1980 and 1981 (10 years) were 5 years lower than for applicants (~15 years).
- The average YSD for the K07 awardees FY1983 through 1990 were slightly higher (8.1 years) than for applicants (6.2 years), but leveled off to be the same or slightly lower than for applicants from 1991 through present (6.5 years for awardees versus 6.7 years for applicants).
- The average YSD for the K22 awardees FY2000 through 2003 was slightly higher (9.1 years) versus applicants (8.4 years).
- The average YSD of K12 Awardees (PIs) was slightly lower (23.1 years) than applicants for most years.
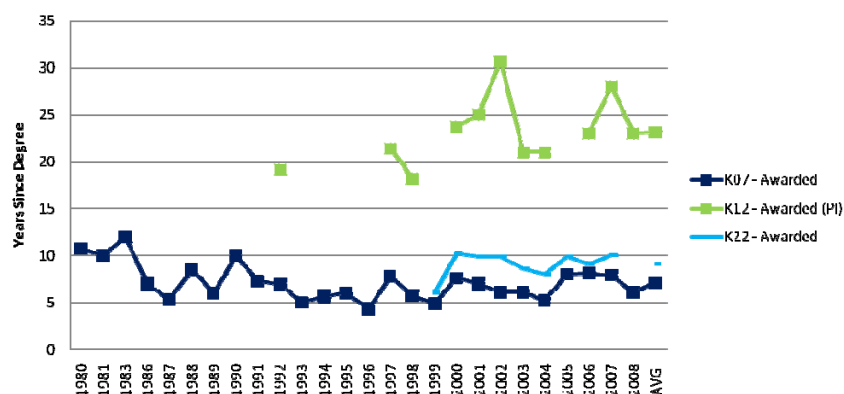
Figure 32. Average years since degree for awardees of targeted K mechanisms, by fiscal year.

3.5 Success Rates for Targeted NCI K Mechanisms

The NIH defines success rate as the percentage of reviewed grant applications that receive funding for a given fiscal year[11]. For this discussion, success rate represents a calculation of those applications to NCI K mechanisms that were funded for a given fiscal year, and does not include factoring for carryovers or amendments. The overall success rate of K07 awardees across fiscal years was 33.5%; K12 (PIs) had a 38.6% success rate and K22 awardees had the lowest overall success rate at 22.7% (See Table 2).

Figure 33 compares the success rates of the three NCI K mechanisms analyzed in detail for this feasibility study. Overall, the K07 and K12 mechanisms show more variance year-to-year than the K22. For the K07 mechanism, this could be attributed to the relatively low applicant and awardee numbers in the earliest years and could be resolved by binning these data into 5 year cohorts, such as what was done for the gender analyses. Variance in the K12 mechanism is also most likely attributable to overall low numbers of applicants and awardees for the program. The K22 mechanism shows the least amount of variance in year-to-year success rate, and recent rates (FY2005 to FY2008) are closest to the success rate of NCI research project grants (RPGs) for FY2008 (20.6%).[12]
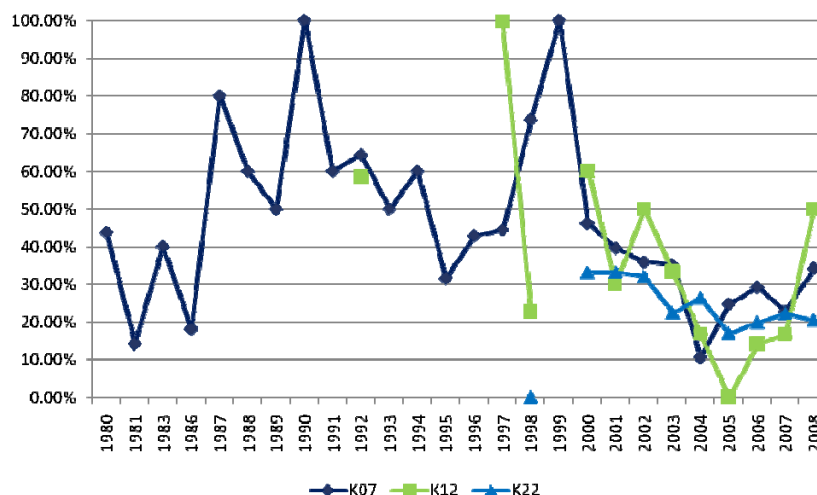
Figure 33. Success rate of targeted NCI K mechanisms by fiscal year.

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[11] NIH Success Rate Definition. http://report.nih.gov/UploadDocs/NIH_Success_Rate_Definition.pdf. (Accessed Oct.1, 2009).
[12] NIH Research Portfolio Online Reporting Tool (RePORT). http://report.nih.gov/award/success/Success_ByIC_Details.cfm?IC=NCI. (Accessed Oct. 1, 2009).

3.6 Summary of Findings: Applicants and Awardees

Gender

- 63% of applicants and 66% of awardees to the NCI K mechanisms are male.

- About 70% of K07 applicants are female, 90% of K12 (PI) applicants are male, and about 60% of K22 applicants are male. Awardee gender ratios are similar to the applicant pool.

- More men than women are listed as K12 Scholars, however, 35% of the Scholar pool is unknown or not matched to IMPAC II.

Race and Ethnicity

- Applicant race/ethnicity demographics are similar to recent doctorate classes. 65% of K applicants are White, 16% Asian, 2% Hispanic, 1% Black, and <1% Native American.   The race and ethnicity of 14% of the applicant pool is unknown/unreported. Awardee demographics are not distinguishable from the applicant pool. Data coverage could be improved by supplementing IMPAC II with data from the DRF and AAMC data sources.

- Race/ethnicity demographics for the K07 applicants and awardees were similar to the overall K distribution. For the K07 program, there were fewer unknown (7-10%) and more Black (2%) and Hispanic (4%) participants. 90% of the K12 (PI) applicants and awardees were White. The K22 applicants and awardees were 55% White, 23% Asian, 15% unknown, 2% Hispanic, 1% Black, and <1% Native American.

Qualifying Degrees

- Overall, about 38% of K program applicants and awardees were PhDs, 36% MD, 23% MD-PhDs, and 2% unknown.

- Qualifying degree demographics varied by K program. K07 awardees were 54% PhDs, 30% MDs, and 16% MD-PhDs. K12 PI awardees were primarily MDs (68%) or MD-PhDs (31%). K22 awardees were 37% PhDs, 22% MDs, and 41% MD-PhDs.

Years Since Degree

- K07 applicants received their degree an average of 7.1 years prior to applying, K12 applicants 25.2, and K22 applicants 8.4 years.

- Average years since degree for awardees is higher for K07 (7.1 years versus 6.9 years) and K22 (9.1 years versus 8.4 years) awardees, but lower for K12 PIs (23.1 years), when compared to the non-awardees[13] (26.5 years).

Success Rates

- The overall success rates of the K07 (33.5%) and K12 mechanisms (38.6%) were higher than that of the K22 mechanism (22.7%). This may be attributable to the smaller number of applicants per year for the former programs.

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[13] Non-awardees are a subset of K applicants: those who submitted an application, but did not receive an award.

4.0 Proposed Evaluation Design

This section will discuss the application of the preliminary findings from the demographic analysis of the NCI K mechanisms for a robust evaluation of the NCI K program, including the incorporation of findings from previous analyses of career development programs.

4.1 Recommendations for Which K Mechanisms to Evaluate

There are several approaches that could be used to determine the appropriate K mechanisms or groups of mechanisms for further evaluation. For most mechanisms, one issue that could reduce the utility of conducting the evaluation on a mechanism-by-mechanism basis is the overall low numbers of applications and awards. Similarly, while most mechanisms have at least ten years of data, recently introduced mechanisms, namely the K99 which was first awarded in FY2007, do not yet have the depth of data necessary to sustain an evaluation of program outcomes at this time. Program longevity is particularly important since most K mechanisms provide 3 to 5 years of support, and thus there is an inherent delay in the ability to evaluate the impact of the program. Regardless of program size, it is certainly possible to provide descriptive statistics for all K programs, including applicant and awardee demographics, success rates, and funded and unfunded applicant outcomes. However, to evaluate program impact on participants using regression discontinuity analysis does require a certain minimum number of participants, and certain review scoring characteristics. With these factors in mind, programs most suitable for impact evaluations are the K01, K04, K07, K08, and possibly the K23 mechanisms.

To overcome program size constraints, it may be possible to combine similar K mechanisms, for example those that target a comparable applicant pool (e.g., early career physicians or early career basic researchers) or those that are focused upon the same area of research (e.g., cancer prevention and control, basic research, or translational/clinical research). One of the risks associated with pooling is that program-specific outcomes may be diluted or lost within the larger population.

Institutional awards (K12) or awards granted to mentor PIs (e.g., K05 and K24) introduce unique evaluation challenges. There are no IMPAC II records established for the scholars who receive training under the award; instead NCI manually curates the scholar list. We found that the data collected by the awardee institutions and provided to NIH were of poor quality, with frequent misspellings, missing first and middle names, and lacked additional supporting information such as email address or date of birth that may have helped to compensate for quality issues. This increased the likelihood that scholar records could not be matched to data sources such as IMPAC II and MEDLINE for outcomes analysis.

- **Recommendation 1:** For impact evaluations, NCI should select programs with at least 10 years of data and over 100 participants. Since most K programs provide 3 to 5 years of support, there should be a "lag" between the award date and the evaluation to allow for accrual of outcomes such as grant applications and publications.
- **Recommendation 2:** For future evaluations, NCI should address K trainee data quality issues by standardizing what data are collected and how data are stored. NCI should require that scholar data include full first name, middle name/initial, last name, date of birth, degree(s), and degree year(s), with each of these fields stored in a separate database field.

4.2 Recommendations for Specific Evaluation Questions

The introductory material to this report included five broad questions to be considered as part of an evaluation of the NCI K award program:

1) **What are the demographics of NCI K award program applicants and awardees?**
2) **What are the performance and post-award outcomes of NCI K awardees?**
3) **To what extent has the NCI K award program met its goals?**
4) **What impact does receiving an NCI K award have on career outcomes?**
5) **How do NCI K awardees compare to unsuccessful applicants or participants in other similar career development programs?**

In this section, we will explore how these questions can be expanded, descriptive statistics that could be applied to learn more about applicants and recipients of NCI K awards, and methods and metrics for evaluating the outcomes and impact of the NCI K program.

4.2.1 Demographics

A more in depth exploration of the demographics of the applicant and awardee pools for NCI K mechanisms will allow for a comparison of the individuals who receive or apply but do not receive NCI K awards. Demographic data could also be used to determine similarities and differences between the NCI K mechanisms and targeted applicant pool. Specific demographic questions could include:

- What are the demographics of the NCI K award program applicants and awardees across mechanisms?
- What are the variations in the demographics of the NCI K award program applicants and awardees among mechanisms? Can mechanisms be grouped by demographic similarities or are programs reaching unique audiences?
- Are there demographic differences between funded and unfunded applicants?
- How many applicants had NIH support prior to receiving a K award?

4.2.2 Career Outcomes and Performance

The overall purpose of the proposed evaluation is to assess whether receipt of an NCI K award had an impact on the likelihood of pursuing a career in cancer research. There are multiple indicators that could be evaluated to assess investigator performance and post-award outcomes, including authorship of publications, application and/or receipt of subsequent NIH or non-NIH research project grant funding, academic appointment, membership in professional societies, and others. Specific outcomes and related data sources for evaluating such outcomes are listed in the table presented in **Appendix 7.3**.

4.2.2.1 Publications

There are two ways in which a publications indicator could be employed. To determine the direct effect of the K award on publication activity, the evaluation could track publications directly citing the K award in the acknowledgments. There are some caveats to using this sort of measure, due to the variance between journals regarding the availability of space to acknowledge research support within research articles, and variations in likelihood of an investigator to acknowledge their NIH funding. Both of these caveats are more important in pre-2000 data.

The second method by which publications could be used as a measure of career outcomes is to explore the number of post-K award publications authored by an awardee. By following the publication activity of an investigator 0-3, 4-6, 7-9, and 10+ years after receipt of an award, an evaluation could assess the number of publications directly attributed to the award (those published in the 0-3 and 4-6 year timeframes) and those subsequent to the award (most likely published in the 7-9 and 10+ year timeframes). This type of analysis was employed in an evaluation of the outcomes of the NCI Cancer Prevention Fellowship program as a way to measure the effect of the fellowship on the number of first-author publications by an individual (Dores, et al. 2006).

In addition to the total number of publications authored by an individual, the number of times each paper is cited and the impact factor of the journal in which a publication appears (as calculated by Thomson Reuters[14]) can be used as measures of research impact. Co-author and co-citation analysis can be used to determine research networks and measure researcher connectivity and centrality in a field.

Publication data could be used to evaluate shifts in primary research focus for participants in the K25 mechanism, which is intended to attract researchers from non-biomedical fields to work in cancer biology. Specifically, one would predict that publication topics (as measured by the Medical Subject Heading (MeSH®)[15] terms associated with publications) would be different pre- vs. post- funding.

4.2.2.2 Subsequent Funding

Pursuit and acquisition of research funding is a reliable measure of whether or not an individual is following a research-oriented career path. Therefore, a significant portion of the outcomes evaluation should focus on whether K awardees apply for and receive funding from the NIH, other federal sources, or non-profit foundations. Specifically, the following questions should be addressed:

- What proportion of the K awardees appear as key personnel on subsequent NIH grants?
- What proportion of the K awardees apply for subsequent NIH funding?
- What proportion of the K awardees are PIs on subsequent NIH funding?
  - What grant mechanisms are represented?
  - Are there trends or variations in subsequent grant mechanisms by K program?
  - What is the average time to first R01 award?
- From which ICs do K awardees receive subsequent NIH funding?
- How many K awardees received subsequent funding from non-NIH sources?
  - How many from DOD, DOE, or NSF programs?
  - How many from cancer-related foundations, including the American Cancer Society, Susan G. Komen Breast Cancer Foundation, Prostate Cancer Foundation, Breast Cancer Research Foundation, and Avon Foundation?

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[14] Introducing the Impact Factor. http://www.thomsonreuters.com/products_services/science/academic/impact_factor/. Accessed Oct. 12, 2009.
[15] National Library of Medicine Fact Sheet: Medical Subject Headings (MeSH®). http://www.nlm.nih.gov/pubs/factsheets/mesh.html. Accessed Oct. 8, 2009.

Information about subsequent NIH funding would be obtained from IMPAC II. We have conducted a preliminary exploration of the ability to match recipients of NCI K awards (or Scholars/mentees for institutional awards) to the databases for other federal funding sources including DOD, DOE, and NSF (see **Appendix 7.2**). The International Cancer Research Portfolio (ICRP) website[16] could serve as a rich source of information regarding funding sponsored by foundations (American Cancer Society, Prostate Cancer Foundation, Susan G. Komen Breast Cancer Foundation, and others) as well as state-based or even international sources of cancer funding. Other foundations provide awardee lists on their public websites.

4.2.2.3 Professional Appointment
As outlined in the introductory material, the majority of the NCI K mechanisms are targeted to early career investigators who are transitioning from a mentored research environment to an independent research career. Thus one measurable outcome is whether or not K awardees received a faculty appointment subsequent to receipt of the award.

Although K applicants and awardees may choose to practice medicine or conduct research at a medical college or university, many of the MDs or MD equivalents may also choose to return to private practice. Since these individuals most likely do not have IMPAC II records subsequent to the K award, an additional data source that tracks physicians in private practice, namely the AMA Physician Masterfile[17], could be used to track the careers of this group.

Several of the K mechanisms are focused on encouraging researchers and physicians to pursue patient-oriented or clinical research. Therefore, it could be informative to determine how many awardees continue participating in clinical research by matching them as the overall PI for a grant with a clinical trial/human subjects component or to site PIs for clinical trials registered with clinicaltrials.org, and recorded in the MEDLINE database. It is also possible that clinical research activities could be recorded in the AMA Physician Masterfile, which could be used as a secondary source for this type of career information.

Undoubtedly, there are K awardees that have chosen to pursue a non-research career, but are still working in cancer-related sectors, such as pharmaceutical or biotechnology companies or as research directors at non-profit cancer research foundations. While these individuals will be more challenging to locate, we have demonstrated some success in tracking current professional appointments using the professional networking website LinkedIn. A list of K12 Scholars never matched to an IMPAC II was used to obtain test data of our ability to locate these individuals using LinkedIn. Of the 109 names, 18 (16.5%) had LinkedIn profiles. While we will not be able to track all "non-research" individuals through LinkedIn, it would allow for us to identify additional career paths of those receiving an NCI K award, and possibly identify more formal data sources for tracking these groups.

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[16] International Cancer Research Portfolio website: http://www.cancerportfolio.org/index.jsp. Accessed on October 12, 2009.
[17] Information about the AMA Physician Masterfile can be found at: http://www.ama-assn.org/ama/pub/about-ama/physician-data-resources/physician-masterfile.shtml. Accessed on October 12, 2009.

4.2.2.4 Patents

The number of patent applications and/or patent awards attributed to a K awardee is a measurable outcome. This could be measured by searching for patent applications/awards attributed to the NCI K grant number or matching PI name to patent inventors.

4.2.2.5 Professional Societies and Awards

Membership in professional societies and receipt of research related awards can also serve as measures of professional outcomes. Specific evaluation questions could include:

- What percentage of K awardees has membership in a cancer-related professional society?
- What percentage of K awardees has received honors, awards, or other scientific prizes for cancer-related research?

Data sources for this information could include ResearchCrossroads (for basic researchers) and the AMA Physician Masterfile, although organizations such as the American Association for Cancer Research (AACR), the American College of Medical Genetics (ACMG), or the Federation of American Societies for Experimental Biology (FASEB) might be willing to help match NCI K awardees to their membership files for such an evaluation. In fact, an initial exploration of the percentage of society members serving as PIs on NIH extramural grants was conducted by FASEB in 1995 and included a relatively detailed analysis of the K mechanisms (Garrison and Heinig 1995).

4.2.2.6 Review and Advisory Panels

Individuals who are considered leaders within their field of study are frequently recruited to serve on NIH study sections to review and evaluate grant proposals, or appointed to federal advisory committees whose activities can range from developing federal policies related to specific areas of research to reviewing the application and efficacy of medical devices. IMPAC II contains fields that track an individual's participation in NIH study sections. We conducted a test of the NCI K22 awardees to assess the usability of these data, and determined that 33 of the 73 awardees participated in a total of 36 committees/review groups. The publicly accessible website FIDO.gov (Federal Information Database Online), provides a listing of all individuals who are currently serving or who have previously served as members on federal advisory committees, and could also serve as a resource for identifying individuals providing review or advisory service to FDA, CDC, AHRQ, HRSA, or Departmental (e.g., reporting to the Secretary of DHHS) committees.

4.3 Recommendations for Comparison Groups

Comparison groups provide a mechanism through which outcomes of the recipients of NCI K awards can be compared to other career development awards, serving as a means to evaluate program effectiveness. For individual awards, outcomes of K awardees can be compared to those K applicants not receiving the award. In addition, the following three groups could serve as comparison groups in an evaluation of the NCI K award program.

4.3.1 LRP Contract Recipients: The NIH loan repayment programs are intended to attract and retain early career health professionals in biomedical and behavioral research careers. The LRP program

exchanges repayment of up to $35,000 per year of educational loan debt for a 2-year commitment to conduct qualified research. The employment and career outcomes of a years-since-degree matched group of LRP awardees and K awardees could be compared, with a particular focus on the measurement of subsequent NIH grant applications and awards. Such an analysis has been performed in the recent LRP Program Evaluation. (National Institutes of Health LRP Evaluation Working Group 2009)

4.3.2 NCI T32 Training Grants: The T32 grant mechanism supports Institutional training grants to develop or enhance research training opportunities for individuals pursuing full-time pre- or postdoctoral studies in biomedical or behavioral research. T32 grantees institutions may receive up to 5 years of support and recipients of the funding are determined by the institution. For a time-since-degree matched group, the career and employment outcomes for T32 awardees and K awardees could be compared, with a particular focus on subsequent NIH grant applications and awards.

4.3.3 NCI F32 Fellowships: F32 fellowships provide three years of support to individuals with a doctoral degree (e.g., MD, PhD, DPH) to pursue supervised research with the goal of achieving independence. For a time-since-degree matched group, the career and employment outcomes for F32 fellows and K awardees (preference could be for those K mechanisms focused on basic research) could be compared, with a specific focus on subsequent NIH grant applications and awards.

4.4 Recommendations for Data Sources

The NIH IMPAC II database served as the primary data source for the preliminary demographic information presented within this report, and would serve as the primary source for establishing the list of applicants to and awardees of NCI K awards. **Appendix 7.3** outlines the variables to be explored in a larger evaluation of the NCI K program and the related data sources.

- **Recommendation 3:** For demographic analysis, the Doctorate Records File (DRF) and the AAMC Faculty Roster (AAMC) should be used to supplement IMPAC II data, as these sources are better populated and include more detail in the categorization of race and ethnicity than IMPAC II.
- **Recommendation 4:** For outcomes analysis, NCI should consider obtaining a license to the American Medical Association (AMA) Physician Masterfile. This datasource contains information on all physicians in the U.S. who have completed or are completing requirements to practice medicine in the U.S. It includes demographic, educational, and professional information, and could be a useful source for tracking outcomes of K awardees who have chosen to enter private medical practice.
- **Recommendation 5:** For outcomes analysis, NCI should consider using the social networking website LinkedIn as a primary source for post-award information for individuals who have chosen to pursue a non-research career, such as executive positions at pharmaceutical/biotechnology companies or science policy.

5.0 Workplan for Evaluation

Below is presented a task plan and estimated time and cost for an evaluation of the NCI K programs. This evaluation plan includes descriptive statistics and outcomes for the applicants and awardees to all NCI CCT CTB K programs; an impact evaluation and publications analysis for the K01, K04, K07, and K08 programs; and a final report and slide set.

Tasks would include:

1. Demographic analysis of applicants and awardees, including analysis of gender, race/ethnicity, degrees, years since degree, multiple applications, and success rates.
2. Outcomes analysis, including descriptive statistics of outcomes for all K awards and impact analysis for K01, K04, K07, and K08 mechanisms.
3. Publications analysis, including aggregated and person-based publication data for K01, K04, K07, and K08 applicants and awardees.
4. Final report and presentation.

A team comprised of a program manager, engineer, analyst and subject matter expert would be required to carry out these tasks. An estimated 2,100 hours would be required to complete the evaluation, at a cost of $316,000 over a period of two years.

Additional costs (ODCs) may be necessary to obtain access to AMA Physician Masterfile or other data sources to support the outcomes evaluation.

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7.0 Appendices

7.1 NCI K Mechanisms

Mechanism	Description	Research Discipline	Support Years	Qualifying Degree(s)	Applicant Career Stage	Program Initiated	Program Terminated
K01[§]	Award is intended to bridge the transition from mentored research environment to an independent research career in cancer research.	• Basic Sciences	Up to 5 years	MD PhD MD/PhD	• Early career (post-doc to faculty transition)	1997	July 1, 2006 (no new awards made after this time. Program being replaced by K99/R00 Award)
K04[*]	Award is intended to bring a promising and developing researcher to the status of a fully independent investigator.		Up to 5 years	PhD	• Early career		No new awards made after 1996
K05	Award provides support for established investigators to conduct research in cancer prevention, control, behavioral and population sciences and to mentor early career investigators in these fields.	• Cancer Prevention, Control , Behavioral and Population Sciences	Up to 5 years	Research or health-professional doctoral degree or equivalent. Expected to have peer-reviewed, independent research support from a federal agency at time of application.	• Established investigators	2001	
K06[#]	Award provides support to established investigators of high competence for the duration of their careers as long as they successfully obtain peer-reviewed research grant support.						
K07	Award provides support for early career investigators to conduct research in cancer prevention, control, behavioral and population sciences research	• Cancer Prevention, Control, Behavioral and Population Sciences	3 - 5 years	PhD Health Professional Doctoral degree (MD, DrPH, DDS,DO, DVM, PharmD or equivalent) Doctorally prepared oncology nurse	• Postdoctoral fellows • Non-tenured Junior Faculty	1980	
K08[*]	Award provides support to individuals with a clinical doctoral degree to receive mentored training in laboratory-based biomedical, behavioral, or translational research targeted to the diagnosis, management, or prevention of cancer.	• Basic Sciences • Translational Research	Up to 5 years	MD (or equivalent) PhD in clinical discipline	• Postdoctoral and Clinical Fellows • Non-tenured Junior Faculty	1984	

Mechanism	Description	Research Discipline	Support Years	Qualifying Degree(s)	Applicant Career Stage	Program Initiated	Program Terminated
K11[*]	Award is intended to provide long-term basic, clinical, or behavioral research training to MDs; Phase I provides didactic study and laboratory experiences while Phase II allows recipients to pursue an intensive research project.		Phase I, 2-3 yrs; Phase II, 2-3 yrs.	MD	• Early career	1995(?)	NIH Notice (NIH Guide, Volume 24, Number 15, April 28, 1995) describes replacement programs, including K11.
K12	Award provides multi/trans-disciplinary institutional training to support the development of research careers of clinicians or clinicians and basic scientists in patient-oriented, therapeutics development research.	• Clinical Science: Patient-Oriented Research • Translational Research	Up to 5 years	MD (or equivalent) for clinicians; PhD (or equivalent) plus 2 years postdoctoral research for basic researchers	• Established investigators	1992	
K22	Award provides "protected time" for newly independent investigators to develop and receive support for their initial cancer research programs. Applicants can be clinicians pursuing basic science careers; clinicians pursuing careers in patient-oriented research; or individuals pursuing careers in cancer prevention, control, and population sciences.	• Cancer Prevention, Control, Behavioral and Population Sciences • Transdisciplinary Sciences • Basic Sciences (MDs only)	Up to 3 years	MD, PhD, DPH	• New faculty in first independent research positions	2000	
K23	Award provides support for the career development of clinical professionals to conduct mentored patient-oriented research projects.	• Clinical Science: Patient-Oriented Research • Translational Research	Up to 5 years	Clinical doctorate (MD, oncology nurse) or equivalent. PhDs must be certified to conduct clinical duties	• Non-tenured Junior Faculty with a Clinical Degree	1999	
K24	Award for midcareer clinicians to provide "protected time" to conduct patient-oriented (human subjects) research and serve as mentors for early career clinical investigators. Applicants should be at the Associate Professor level or functioning at that rank.	• Clinical Science: Patient-Oriented Research	Up to 5 years	Health-professional doctoral degree and clinical PhDs.	• Midcareer investigators	1999	

Mechanism	Description	Research Discipline	Support Years	Qualifying Degree(s)	Applicant Career Stage	Program Initiated	Program Terminated
K25	Award supports the career development of investigators with backgrounds in quantitative and engineering sciences (e.g., outside of biology or medicine) who have chosen to focus their research on behavioral and biomedical research (basic or clinical).	• Cancer Prevention, Control, Behavioral and Population Sciences • Transdisciplinary Sciences • Basic Sciences (MDs only)	3 - 5 years	MSEE, PhD, DSc	• Postdoctoral to Senior Faculty Quantitative Scientists	2001	
K99	Award facilitates receipt of an R01 award earlier in an investigator's research career, and support is composed of two phases. The K99 phase provides 1-2 years of mentored support for postdoctoral scientists, followed by 3 years of independent support (R00). The R00 phase is dependent upon the recipient obtaining an independent research position.	• Basic Sciences	Up to 5 years	Doctoral degree	• Postdoctoral Fellows	2007	

§ Goals of the mechanism may have changed over the course of the program's lifespan. Notice in *NIH Guide* (vol. 24, number 15, April 28, 1995).

Terminated program for which little descriptive information is available.

* Terminated program for which limited descriptive information is available.

7.2 Database Matching Report

	K01 n=155	K04 n=357	K05[18] n=150	K06[19] n=11	K07 n=278	K08 n=529	K11 n=87	K12[20] n=373	K22 n=73	K23 n=101	K24 n=53	K25 n=25	K99 n=55
IMPAC II	153	345	93 (62%)	11	276	517	87	245 (66%)	73	99	53	25	54
NED	4 (3%)	30 (9%)	12 (8%)	0	21 (8%)	40 (8%)	9 (10%)	29 (8%)	7 (10%)	16 (15%)	13 (24%)	2 (8%)	3 (6%)
DoD (DTICRS)	1 (1%)	11 (3%)	2 (1%)	0	0	8 (2%)	0	10 (3%)	0	2 (2%)	2 (4%)	1 (4%)	0
Enumer-ation	114 (75%)	177 (51%)	35 (23%)	1 (9%)	201 (73%)	326 (61%)	42	124 (33%)	44 (60%)	71 (65%)	44 (81%)	15 (60%)	19 (35%)
Medline[21]	84 (55%)	295 (86%)	36 (24%)		182 (66%)	317 (59%)	50 (57%)	43 (12%)	36 (49%)	55 (50%)	48 (89%)	6 (24%)	9 (17%)
NSF FastLane	36 (24%)	175 (51%)	7 (5%)		31 (11%)	119 (22%)	22 (25%)	25 (7%)	19 (26%)	23 (21%)	11 (20%)	16 (64%)	22 (41%)
DOE	5 (3%)	24 (7%)	1 (1%)		3 (1%)	15 (3%)	0	6 (2%)	1 (1%)	1 (1%)	2 (4%)	2 (8%)	2 (4%)
DRF	109 (71%)	230 (67%)	53 (35%)		157 (57%)	165 (31%)	13 (15%)	127 (34%)	41 (56%)	15 (14%)	10 (19%)	16 (64%)	31 (57%)
AAMC	98 (64%)	248 (72%)	38 (25%)		191 (69%)	433 (81%)	70 (80%)	203 (54%)	50 (68%)	81 (74%)	51 (94%)	9 (36%)	21 (39%)

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[18] Database analysis for K05 program included 31 Mentors and 119 Mentees.

[19] Database analysis for K06 program did not include Medline, NSF FastLane, DOE, DRF, and AAMC.

[20] Database analysis for the K12 program was conducted on a list of K12 Scholars curated by the NCI CCT-CTB.

[21] MEDLINE data includes only those papers that acknowledge K funding. Manual curation would be required to verify additional papers prior and subsequent to the K award; this was outside of the scope of the feasibility study.

7.3 Study Variables and Data Sources

Variable	Data Source (s)
Gender	IMPAC II
	DRF
	AAMC
Race/Ethnicity	IMPAC II
	DRF
	AAMC
Age (derived from Date of Birth)	IMPAC II
	DRF
	AAMC
Degree(s)	IMPAC II
	DRF
	AAMC
Years Since Degree	IMPAC II
	DRF
	AAMC
Prior NIH Support	IMPAC II
Subsequent NIH Support	IMPAC II
Non-NIH Federal Research Support	DoD DTIC
	DOE
	NSF FastLane
Non-Federal Research Support	International Cancer Research Portfolio
	Research Crossroads
	American Cancer Society
	Breast Cancer Research Foundation
	Avon Foundation
Faculty Appointment	AAMC
Private Medical Practice	AMA Physician Masterfile
Non-Research Careers	LinkedIn, google.com
Publications	Medline
	Thomson-ISI
Scientific Awards	Research Crossroads/RAISE
Federal Advisory Committees and Grant Review Panels	IMPAC II
	FIDO.GOV