

National Institutes of Health

Physician-Scientist Workforce Working Group Report

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In a word, I consider hospitals only as the entrance to scientific medicine; they are the first field of observation which a physician enters; but the true sanctuary of medical science is a laboratory; only there can he seek explanations of life in the normal and pathological states by means of experimental analysis.¹

Claude Bernard, 1865

¹ Bernard, Claude, *An Introduction to the Study of Experimental Medicine* (Dover edition 1957; originally published in 1865; first English translation by Henry Copley Greene, published by Macmillan & Co., Ltd., 1927)

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Executive Summary

Dr. Francis Collins, NIH Director, convened and charged the Physician-Scientist Workforce Working Group (PSW-WG) with analyzing the current composition and size of the physician-scientist biomedical workforce and making recommendations for actions that NIH should take to help sustain and strengthen a robust and diverse PSW. The need for the PSW-WG emerged from the recommendations of the [Biomedical Research Workforce Working Group](#) for strengthening the biomedical workforce. Its June 2012 report concluded that the training and career paths of physician-scientists were different than that of the non-clinician PhD workforce and that further study of this important segment of the workforce was needed.

Warning bells about the health of the physician-science workforce were sounded as early as 1979 when future NIH Director James Wyngaarden observed that the physician-scientist with a medical degree was becoming “an endangered species.” He had observed that MD applicants for NIH project grants represented a progressively smaller fraction of all applicants than previously, while the corresponding fraction of PhD applicants had increased dramatically. In 1996, NIH established a committee headed by David G. Nathan to make recommendations about the perceived shortfall of clinician scientists. The Nathan Committee recommended creating new career development grants for patient-oriented research and loan repayment programs to help young physician-scientists pursue research careers despite an increasing load of educational debt.

In spring 2013, the PSW-WG met and established subcommittees to discuss issues confronting the physician-scientist workforce. To inform its deliberations, the PSW-WG directed quantitative analyses of NIH IMPACII and other relevant databases to answer key questions, and considered the findings from qualitative research based on focus groups and interviews with students, research deans, and early career investigators.

The PSW-WG defined physician-scientists as scientists with professional degrees who have training in clinical care and who are engaged in independent biomedical research. The PSW thus includes individuals with an MD, DO, DDS/DMD, DVM/VMD, or nurses with research doctoral degrees who devote the majority of their time to biomedical research. The PSW-WG recognizes that the primary goal of professional clinical education is the training of a skilled clinical workforce in the respective areas of practice, and that the portion of such professionals devoted to research will be small. However, findings which lead to advances in practice are driven largely by the work of investigators with a variety of degrees, of whom those with clinical training contribute essential knowledge and skills.

Key Findings

NIH is the primary funder of biomedical research and research training in the United States. The strength of the physician-scientist workforce reflects the nature of the nation’s investment in this arena. NIH funding increased greatly in the late 1990s from \$13.675 billion (1998) to \$27.167 billion (2003). During this period, institutions expanded their research capacity and training programs, and the number of physicians and non-clinically trained researchers applying for NIH R01 grants increased. NIH’s budget growth came to a halt in 2004 and has since remained static. After adjusting for inflation using the Biomedical Research and Development Price Index, the 2013 NIH budget was 21.9 percent below its

2003 level. The 2008 recession also reduced research funding from other sources, including pharmaceutical companies.

Size and Composition of the NIH-funded Physician-Scientist Workforce

It is difficult to obtain accurate numbers about the total size of the physician-scientist workforce because the data are considered proprietary by the pharmaceutical and medical device industries, and because data are not available on the number of physician-scientists whose research is funded by non-NIH sources. PSW-WG analyses indicate that there were approximately 9,000 physician-scientists in the NIH-funded workforce during 2008-2012, including 4,192 with an MD, 4,086 with an MD/PhD, 341 nurse-scientists, 253 veterinarian-scientists, and 161 dentist-scientists.

Though their percentage of the overall biomedical workforce has been steadily decreasing since the 1970s, the total number of physician-scientists with a medical degree has remained remarkably steady over the past few decades, with MDs and MD/PhDs each comprising about 50 percent of the physician-scientist workforce with a medical degree. At the same time the average age of entry into the independent workforce (marked by receipt of an NIH RPG) has increased steadily, as has the average age of the physician-scientist workforce.

Nearly three-quarters of the MD RPG awardees were white and another one in five were Asian. Although there has been significant growth for Asian and Hispanic awardees over the past decade, there has been less growth for African-Americans and Native Americans. The lack of diversity of the physician-scientist workforce is a source of very serious concern to the NIH and to the professions. Other groups are addressing these difficult issues; the PSW-WG did not attempt to duplicate their efforts, and endorses strong investment in improving minority participation in scientific leadership.

Female physician-scientists remain underrepresented in some segments of the NIH-funded physician-scientist workforce. For physician-scientists with a medical degree, the percentage of female MDs who are RPG grant holders has increased from 17 percent in the mid-1990s to 29 percent currently. However, for MD/PhDs, growth in women investigators has been slower, increasing from 17 percent in the mid-1990s to 22 percent at the present time. Among veterinarian-scientists who receive RPGs from the NIH, men outnumber women by about three to one, despite the fact that the overwhelming majority (90 percent) of students enrolled in schools of veterinary medicine are women.

In contrast, among nurse-scientists applying for and receiving RPGs from NIH, women outnumbered men by approximately nine to one, reflecting their numerical dominance in the profession. Among dentist-scientists, women received about one-third of the RPGs awarded, yet constitute only about one-quarter of the dental-research workforce.

Challenges Confronting the Physician-Scientist Workforce

Several challenges confront the physician who elects to pursue a research career. Increases in the cost of obtaining medical education can burden students with high amounts of debt, especially those who were not enrolled in an integrated MD/PhD program. The training required to obtain competency in clinical and scientific research continues to increase, resulting in a marked prolongation of the training process. The transition between finishing a clinical or post-doctoral fellowship and initiating an independent research position is a very vulnerable period in the career path of all physician investigators. Funding pressures have mounted with the decrease in NIH funding and physician-scientists are increasingly being asked to support a higher percentage of their income by seeing patients. Financial opportunities in

practice offer an attractive option for clinically-trained physician-scientists, who are also valuable as clinicians to academic medical centers, pulling them away from their investigative work and creating conflicting demands on time and energy.

Other challenges that particularly confront younger physician-scientists are finding ways to balance work/life demands, finding mentors who can support and guide early career investigators, and the increasingly time-consuming and demanding requirements to maintain clinical credentials.

Physician-scientists across all domains face similar challenges, although the extent of the challenges varies from discipline to discipline. The non-MD segments of the PSW have lacked a critical mass of scientific researchers due to the strong focus of veterinary, dental and nursing training programs on producing clinical practitioners. As a result, a major challenge among these segments of the physician-scientist workforce is a shortage of faculty members with scientific research programs who can serve as role models and mentors to students in training.

Nurse-Scientists. Nurses often obtain research training after several decades of clinical work, and thus begin their research careers later than other clinical researchers. This contributes to the shortage of nursing faculty to train the next generation of nurse-scientists.

Veterinarian-Scientists. The curriculum in veterinary schools of medicine does not typically promote the role of the veterinarian-scientist, reflected in the significant lack of investment and lack of critical mass of veterinarian-scientists. Students graduating from veterinary school carry a heavy load of student debt, which discourages pursuit of a research career that may pay less than clinical practice.

Dentist-Scientists. A significant concern in dental education is the number of vacant faculty positions. Other challenges include financial pressures on dental schools, leading to increased emphasis on clinical revenue generation and a decreased emphasis on research. As a result, the culture and environment within dental schools has led to a diminished pool of research faculty mentors for dentist-scientist trainees, coupled with a lack of understanding and support for the training and career development of dentist-scientist graduates.

Future Challenges. A number of forces outside the NIH pose great challenges to the future physician-scientist workforce, including dramatic changes in the economics of medicine and healthcare more broadly, rising educational debt, increasing length of training, growing regulatory burdens, challenges to the overall quality of Science, Technology, and Mathematics (STEM) education in the United States, and the changing demographics of students in medical, dental, and veterinary schools. Individuals who have obtained one or more degrees outside the United States also comprise a significant component of the physician-scientist workforce, which has not been adequately characterized.

Challenges Confronting the National Institutes of Health in Assessing the Health of the Biomedical Workforce

As part of its charge, the PSW Data Subcommittee reviewed, assessed, and assembled a wide array of data sources in order to describe the size and composition of the current physician-scientist workforce, as well as to evaluate the impact that NIH Research Project Grant (RPG) funding has on the workforce and its development. An important outcome of that investment is the identification, organization, and analysis of a large database of key information about the workforce, drawn not only from NIH's IMPACII database but also from key external organizations such as the Association of American Medical Colleges (AAMC). NIH now has the opportunity to utilize this data in an ongoing and systematic way to address

key biomedical workforce issues—now and in the future—that the agency as a whole, as well as individual NIH Institutes and Centers, must confront as it seeks to strengthen the biomedical research capacity of the United States.

Early Career Investment in the NIH-funded Physician-Scientist Workforce

NIH's investment in the training of physician-scientists has a significant return. The RPG award rates for first-time RPG applicants with a prior LRP or K award are much higher than for those without: For MDs: 44.1 percent vs 9.2 percent and for MD/PhDs: 60.0 percent vs 10.1 percent. Similarly, early career support for physician-scientists through the Medical Scientist Training Program (MSTP) has also been successful at bolstering the physician-scientist workforce. Close to 80 percent of a cohort of MD/PhDs with past MSTP Appointments (1980-1989) have applied for RPGs, and approximately 78 percent have been successful. Despite this track record, the number of new physician-scientists with a medical degree entering the workforce is now declining, as reflected in the reduced numbers of applicants for early career (K and LRP) awards over the last 5 years.

Analysis of AMA and NIH data demonstrate continued aging over the past decade of physicians engaged in research, which presage a significant decline in the PSW, especially as the current cohort of senior physician-scientists retires. Our key recommendations thus focus on the early stages of the pipeline, on enhancing the ability of the NIH to evaluate the relative effectiveness of its programs to build and maintain the pipeline, and on systematically collecting and reviewing data so the biomedical workforce can more easily and readily be assessed.

Recommendations

The following recommendations apply to all clinically-trained investigators, including veterinarian-scientists, dentist-scientists, and nurse-scientists.

1. **NIH should sustain strong support for the training of MD/PhDs.** MD/PhD programs (including the Medical Scientist Training Program [MSTP] program funded by NIH) have been successful in promoting the development of physician-scientists and should be continued.
2. **NIH should shift the balance in National Research Service Award (NRSA) postdoctoral training for physicians so that a greater proportion are supported through individual fellowships, rather than institutional training grants.** The number of individual fellowship awards for MD-PhD students (F30/F31 grants) should also be increased. The PSW-WG endorses the similar recommendation from the Biomedical Workforce Working Group that support for both pre- and post-doctoral PhD trainees and individual fellowship for MD/PhD trainees should be expanded. It is critical to obtain accurate long-term follow-up on trainees through all of these programs to assess comparative effectiveness. These results should guide future allocation of NIH funds to these various mechanisms.
3. **NIH should continue to address the gap in RPG award rates between new and established investigators.** Although NIH policies have narrowed the gap for new RO1 applicants, this problem remains significant and needs continued attention. A number of pilot approaches should be explored, and rigorously assessed, with the most successful given expanded support (also see #7 below).

4. **NIH should adopt rigorous and effective tools for assessing the strength of the biomedical workforce, including physician-scientists, and tracking their career development and progression.** NIH should collaborate with external organizations that also have a strong investment in workforce development to collect, monitor, and report on key indices related to workforce issues. Specifically, NIH should establish an ongoing workgroup of NIH employees and external partners to support the development of a Biomedical Workforce Dashboard application that provides real-time tracking of the career development and progression of the workforce. The Dashboard would be a tool that both NIH employees and the public could use to instantly answer questions related to important workforce issues at the agency or I/C level.
5. **NIH should establish a new physician-scientist-specific granting mechanism to facilitate the transition from training to independence.** This program should be similar to the K99/R00 program whose funding currently goes almost exclusively to individuals holding a PhD degree. This new grant program could serve either as a replacement or transition from existing K Awards for physician scientists, and should provide a longer period of support, potentially lengthening the R00 phase to 5 years (with an interim staff review at year 3). This new grant series, as well as K and all other training awards, should rigorously enforce protected time of at least 75 percent effort and provide sufficient salary support to make that possible.
6. **NIH should expand Loan Repayment Programs and the amount of loans forgiven should be increased to more realistically reflect the debt burden of current trainees.** This program should also be made available to all students pursuing biomedical physician-scientist researcher careers, regardless of particular research area or clinical specialty.
7. **NIH should support pilot grant programs to rigorously test existing and novel approaches to improve and/or shorten research training for physician-scientists.** These programs should include (but not be limited to) mechanisms to shorten medical and/or laboratory training, explore timing and spacing of the research and clinical components of post-graduate training, and other alternatives. New opportunities for training in informatics and social science research that address emerging needs of the health care system should also be evaluated. Those programs exhibiting the most promising results should receive expanded support.
8. **NIH should intensify its efforts to increase diversity in the physician-scientist workforce.** This Working Group recognized major deficiencies of the physician-scientist workforce with regard to diversity. The PSW-WG strongly endorses the previous recommendations of the preceding biomedical workforce Working Group and the Working Group on diversity, all of which should be extended to the physician-scientist workforce.
9. **NIH should leverage the existing resources of the Clinical and Translational Science Awards (CTSA) program to obtain maximum benefit for training and career development of early-career physician-scientists.** This process should include critical review and analysis of rigorous outcome data, as outlined in #7 above.

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Chapter 1

Introduction

The Physician-Scientist Workforce Working Group (PSW-WG) is a working group of the Advisory Committee to the Director at the National Institutes of Health (NIH), established in the spring of 2013. Dr. Francis Collins, NIH Director, charged the PSW-WG to:

- Develop approaches that can inform decisions about the development of the U.S. physician-scientist (PS) biomedical workforce for the advancement of science and the promotion of health.
- Analyze the size and composition of the physician-scientist biomedical workforce to determine the impact of current funding policies of NIH and other analogous entities on clinicians' decisions to engage in research.
- Assess present and future needs and career opportunities available to support physician-scientist trainees in diverse biomedical research sectors.
- Further identify the incentives and barriers to clinicians entering and continuing to engage in scientific activities.
- The committee will make recommendations for actions that NIH should take to support a sustainable and diverse clinical research infrastructure, as well as recommendations for actions needed by other relevant stakeholders.

The PSW Working Group defined physician-scientists as scientists with professional degrees, who have training in clinical care and who are engaged in independent biomedical research. Those who engage in this type of research could include individuals with an MD, DO, DDS/DMD, DVM/VMD, or nurses with research doctoral degrees who devote the majority of their time to biomedical research.

The Working Group retained the title of "Physician-Scientist" as this is the term historically associated with discussions of this component of the biomedical workforce.

The charge outlined above emerged from the recommendations of the Biomedical Research Workforce Working Group, a constituent working group of the Advisory Committee to Director Francis Collins at the National Institutes of Health (NIH), tasked with addressing how to support a future sustainable biomedical research infrastructure. Its June 2012 report concluded:

The economic and educational drivers which affect the training and career paths of the physician-scientist workforce are very different from those underlying non-clinician PhD research training and career paths and there was not sufficient time for the working group to examine this important part of the biomedical workforce in detail. In addition, the changing landscape of health care and the effects these changes likely will have on

academic medical centers need to be projected carefully and considered when analyzing the future physician-scientist workforce.

Therefore, the working group recommends that NIH conduct a follow-on study that focuses on physician-scientists and involves people who train physician-scientists, as well as economists who focus on medical education costs, career choices, and the role of these as incentives.

Methodology

The PSW-WG met by telephone in April and June of 2013 to begin planning its work, including data needs and organizational approaches that would most efficiently allow the geographically-dispersed members to address the Working Group's charge.

Subcommittee Organization

Based on input from Working Group members, the Co-Chairs created three Subcommittees to consider issues specific to different segments of the physician-scientist workforce:

- Clinical/Translational Physician-Scientists, including Nurse-Scientists
- Laboratory-based Physician-Scientists
- Non-MD Physician-Scientists (Dentist-Scientists, Veterinarian-Scientists)

as well as a Data Subcommittee to oversee data collection and analysis to support the PSW-WG report. The Subcommittees invited ad hoc members to expand expertise in areas underrepresented by the original Working Group membership. These Subcommittees met on a regular basis by telephone between August 2013 and February 2014.

[Appendix I](#) contains a list of the Subcommittees and their membership.

Working Group Meetings

Face-to-face meetings of the full PSW Working Group were held on July 19, 2013 and March 11, 2014, with monthly telephone meetings held between August 2013 and Feb 2014. The last group meeting by phone was held on April 23, 2014.

Quantitative Research

Contractor Thomson Reuters provided support to the Data Subcommittee in mining data from multiple sources to answer key questions identified by the various PSW subcommittees regarding historic trends and current patterns that impact the physician-scientist workforce. The two primary data sources for this Subcommittee were:

- NIH IMPACII Data
- Association of American Medical Colleges (AAMC) Faculty and Student Data

To best understand trends in the workforce, the Data Subcommittee sought to analyze individual physician-scientists, as opposed to applications, since many scientists submit more than one application in a given year. To do this, a record of an individual was created based on all available demographic records within the IMPACII and AAMC Faculty Roster data. As an initial data preparation step, similar applicant profile records were compared and duplicate records were collapsed using automated methods based on NIH's own data management methods but with enhancements that consider additional demographic and application evidence to identify duplicate records. Next, each individual's entire NIH application and appointment history was analyzed to generate a history of prior support at each year in the PSW analysis time frame during which the individual applied to the NIH for support. This history was used to establish an applicant's prior training and fellowship support, as well as prior and subsequent research grant support. In addition, all available educational and demographic information was used to assign individuals to appropriate degree, gender, and race/ethnicity categories as described in [Appendix III](#).

For the purpose of analysing trends over time, an individual applicant was counted only once per Institute/Center (IC) and mechanism in each Fiscal Year (FY). In the event an applicant applied more than once in a given FY to an IC and mechanism, the most recent awarded application was selected to designate him or her as an awardee. Even if an individual submitted applications to more than one IC, he or she was counted once within a given Fiscal Year. In select analyses, termed "5-year rolling windows," an individual was counted once if he or she submitted one or more applications within a 5-year period.

The approach used by the PSW Data Subcommittee differs from standard data reporting at NIH, which normally focuses on reporting application and award total counts and breakdowns. These differences may lead to discrepancies when comparing trends presented here to those reported for applications and awards.

Unless otherwise noted, the source of data for all charts and tables included in this report are from NIH's IMPACII data system, supplemented with AAMC Faculty Roster data, as provided under a data sharing agreement with AAMC. Select reports were generated using data from the NIH Medical Scientist Training Program (MSTP) and summary data from the AAMC's Matriculating Student Questionnaire and Medical School Graduation Questionnaire. Aggregate data on faculty and physician-scientists were provided by the American Medical Association (AMA), the American Dental Education Association, the American Veterinary Medical Association and the Association of American Veterinary Medical Colleges.

In addition, data analyses were carried out with significant support from NIH's Division of Statistical Analysis and Reporting (DSAR) within the Office of Extramural Research. Specifically, DSAR staff provided data on T32 appointees' outcomes and other data review and analysis.

[Appendix II](#) contains information about the methodology used in the quantitative data analysis.

[Appendix III](#) is a description of data definitions used to extract the NIH IMPACII data.

[Appendix IV](#) contains the complete set of relevant graphs generated by the working group with links to underlying data available at NIH *RePORT* website.

Qualitative Research

The Lab-based PS Subcommittee members conducted focus groups with young faculty at their institutions to identify career retention and advancement concerns. Catalyst Research & Communications conducted telephone-based focus groups with medical, dental, and veterinary students. Questions focused on the factors that influenced their decision to pursue a research career. Telephone interviews were also carried out with deans at 15 US medical, dental, and veterinary schools to ascertain their perceptions of how students choose whether to pursue a career in research. Catalyst also conducted interviews with young faculty holding K08 and K23 grants that paralleled the demographics of the faculty members

attending the Lab-based Physician-Scientist Subcommittee's focus groups. Detailed findings of the qualitative research may be found in [Appendix V](#). In January 2014, the National Institute of Nursing Research (NINR) conducted an open-ended survey of a purposive sample of nine deans of nursing schools with research-focused training programs. The purpose of the survey was to gather information regarding the experiences of schools of nursing in training successful nurse-scientists. A summary of the findings may be found in Chapter 4.

Presentation of Findings

This report of the PSW-WG is organized as follows:

[Chapter 2](#) provides the historical context for concern about the vitality of the workforce.

[Chapter 3](#) considers the contributions and challenges of the MD, DO and the MD/PhD physician-scientist workforce.

[Chapter 4](#) considers the contributions and challenges of the nurse-scientist workforce, along with specific recommendations for strengthening this segment of the biomedical research workforce.

[Chapter 5](#) reviews the contributions and challenges of the veterinarian-scientist workforce, including specific recommendations for strengthening this segment of the workforce.

[Chapter 6](#) examines the contributions and challenges of the dentist-scientist workforce, including recommendations for strengthening this segment of the research workforce.

[Chapter 7](#) presents the recommendations of the Physician-Scientist Workforce Working Group for strengthening the workforce overall.

[Appendices](#) at the end of the report contain technical materials that further elucidate the information presented in the body of the report.

Chapter 2

The Physician-Scientist Workforce: Past, Present, & Future

Historical Concerns about the Physician-Scientist Workforce

Despite the critical role that the physician-scientist plays in the biomedical workforce, concern regarding the health of this sector of the scientific enterprise began to grow in the latter decades of the 20th century. The physician-scientist with a medical degree was becoming “an endangered species,” according to James Wyngaarden, who later became an NIH Director, in a 1979 paper in the *New England Journal of Medicine*.² He had observed that MD applicants for NIH project grants represented a progressively smaller fraction of all applicants than previously, while the corresponding fraction of PhD applicants increased dramatically. Subsequently, in 1984, Gordon Gill published an essay titled “The End of the Physician Scientist?” in *American Scholar*.³ He argued that physicians who were engaged in research were increasingly being drawn toward basic laboratory science, excited by the revolution in molecular biology. In 1987, Moody published a paper in the *American Journal of Surgery* that drew attention to the adverse impact of cost containment policies on research in clinical settings.⁴

In response, the Institute of Medicine (1994) undertook a study on overcoming barriers to career paths for clinical research. In 1996, NIH director Harold Varmus established a task force headed by David G. Nathan to make recommendations about how to address the perceived shortfall of clinical investigators. The Nathan Committee recommended creating new career development grants for patient-oriented research and loan repayment programs to help young physician-scientists pursue research careers despite an increasing load of educational debt.⁵

The Association of American Medical Colleges established two task forces on clinical research by physician-scientists. These task forces recommended that clinical research be introduced in undergraduate and graduate medical education curricula and training in clinical research be restructured to accelerate training. In addition, private foundations such as the Burroughs Wellcome Fund, the Doris Duke Charitable Foundation, the Howard Hughes Medical Institute, and the Robert Wood Johnson Foundation created initiatives aimed at revitalizing the physician-scientist workforce.⁶

Nonetheless, an analysis by Zemlo, Garrison, Partridge, and Ley, based on data through the mid-1990s, indicated that medical school students’ intentions to pursue a research career had declined; at the same time, the average debt levels of medical school graduates increased. Their study also found that the number of MDs with NIH training and fellowships declined during this period and that the number of first-time grant applications submitted by MDs remained stagnant.⁷

² Wyngaarden, J.B. (1979). The clinical investigator as an endangered species. *New England Journal of Medicine*, 301(23), 1254-59.

³ Gill, G.N. (1984). The end of the physician-scientist? *American Scholar* 53, 353—69.

⁴ Moody, F.G. (1987). Clinical research in an era of cost containment. *American Journal of Surgery* 153, 337-340.

⁵ Nathan, D.G. & Wilson, J.D. (2003). Clinical research and the NIH: A report card. *New England Journal of Medicine*, 349(19), 1860-65.

⁶ Schafer, A.I. (2009). *The Vanishing Physician-Scientist?* Ithaca, NY: Cornell University Press.

⁷ Zemlo, T.R., Garrison, H.H., Partridge, N.C. & Ley, T.J. (2000). The physician-scientist: Career issues and challenges at the year 2000. *The FASEB Journal* 14, 221-230.

In 1999, Rosenberg emphasized that numerous forces, including the increasing debt burden of medical school graduates, the increasing length of postdoctoral training required, and the instability of NIH funding were responsible in large part for putting the future of the physician-scientist career path at significant risk.⁸

NIH funding increased greatly in the late 1990s from \$13.675 billion (1998) to \$27.167 billion (2003). During this period, institutions expanded their research capacity and training programs, and the number of physicians applying for NIH R01 grants increased. NIH's budget growth came to a halt in 2004 and has since remained static. After adjusting for inflation using the Biomedical Research and Development Price Index, the 2013 NIH budget was 21.9 percent below its 2003 level.⁹ The 2008 recession also reduced research funding from other sources, including pharmaceutical companies.

Garrison & Deschamps' analysis of data from multiple sources, including NIH, through 2011 indicated that physician-scientists' role in biomedical research is more limited than in the past. Among their chief findings, however, was that the decline in the number of physicians entering research careers was temporarily mitigated during the 1998-2003 period of growth in the NIH budget.¹⁰

Although nurse-scientists, dentist-scientists and veterinarian-scientists face many of the same issues—debt, length of training, and funding instability—as physician-scientists with a medical degree, each segment of the workforce contends with other threats. Traditionally, these non-MD segments of the workforce have lacked a critical mass of individuals trained in science and research due to the heavy focus of these training programs on producing clinical practitioners; these professions have been viewed as entirely clinical entities by the public, which has impacted adversely on the number of trainees pursuing a research career in these profession. As a result, there is a shortage of faculty members with scientific research programs who can serve as role models and mentors to students in training.

The Physician-Scientist Workforce

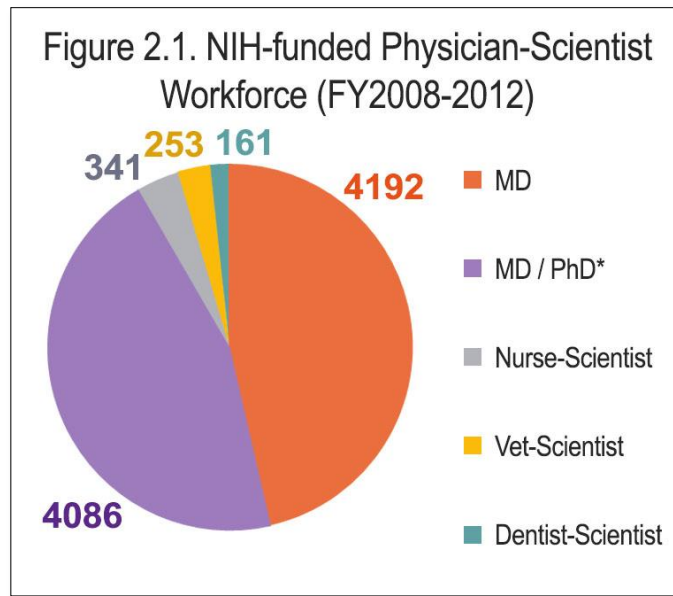
Physician-scientists typically engage in both clinical care and basic or clinical research (though not always at the same point in their career). That combination of experience and training allows the physician-scientist to contribute a unique perspective that encompasses both the “bedside-to-bench” and the “bench to bedside” approach. By both seeing patients and performing research, they can translate clinical observations to the laboratory to help identify the mechanisms of disease, as well as applying the finding of basic science to patient care.

It is difficult to obtain accurate numbers about the total size of the physician-scientist workforce because data is not available on the number of physician-scientists whose research is funded by non-NIH sources, or those employed in the pharmaceutical or medical device industries. PSW-WG analyses indicate that there were approximately 9,000 physician-scientists in the NIH-funded workforce during 2008-2012, including 4,192 with an MD, 4,086 with an MD/PhD, 341 nurse-scientists, 253 veterinarian-scientists, and 161 dentist-scientists (Figure 2.1).

⁸ Rosenberg, L.E. (1999). Physician-scientists—endangered and essential. *Science* 283, 331-332.

⁹ NIH/OEP Staff Calculations.

¹⁰ Garrison, H.H. & Deschamps, A. (2014.). NIH research funding and early career physician-scientists: continuing challenges in the 21st century. *The FASEB Journal* 28, 1-10.



***MD/PhD includes:** MSTP Programs graduates; non-MSTP MD/PhD Program graduates; PhD and MD in series; PhD and/or MD obtained outside U.S.

Among MDs, most physician-scientists fall into one of two broad categories: those who perform research directly with patients in their practice, and those who conduct laboratory-based research. Despite increasing efforts to educate physicians in research methods, the dramatic advances in molecular and cell biology in the second half of the 20th century accelerated a reductionist approach to basic biomedical research, leading to a language barrier between basic scientists and clinical practitioners.¹¹

Among non-MD physician-scientists, each makes specific contributions to biomedical research:

Dentist-scientists. These physician-scientists, like MD-scientists, are positioned to derive their research questions and concepts from clinical (chairside) observations. The 2000 publication “*Oral Health in America: A Report of the Surgeon General*,” concluded that there is a need to support and maintain a biomedical research infrastructure to enhance knowledge about oral disease and improve the oral and general health of the U.S. population.

Veterinarian-scientists. The National Research Council (NRC)’s Committee on Increasing Veterinary Involvement in Biomedical Research (2004), Committee on the National Needs for Research in Veterinary Medicine (2005), and Committee to Assess the Current and Future Workforce Needs in Veterinary Medicine (2013) described multiple roles for veterinarians in biomedical research, including serving as principal investigators, co-investigators, research scientists, and technical advisors. They noted that these individuals also perform important supportive roles as attending veterinarians at research institutions, where they provide medical care for research animals, serve as federally-mandated members of animal care and use committees, and provide technical instruction and advice on experiments utilizing animals.

Nurse-scientists. As the largest group of clinical practitioners in the U.S. healthcare workforce, nurses are uniquely positioned to make important contributions to improving health and quality of life. Nurse-scientists, many of whom conduct clinically-based, patient-oriented research, develop science that

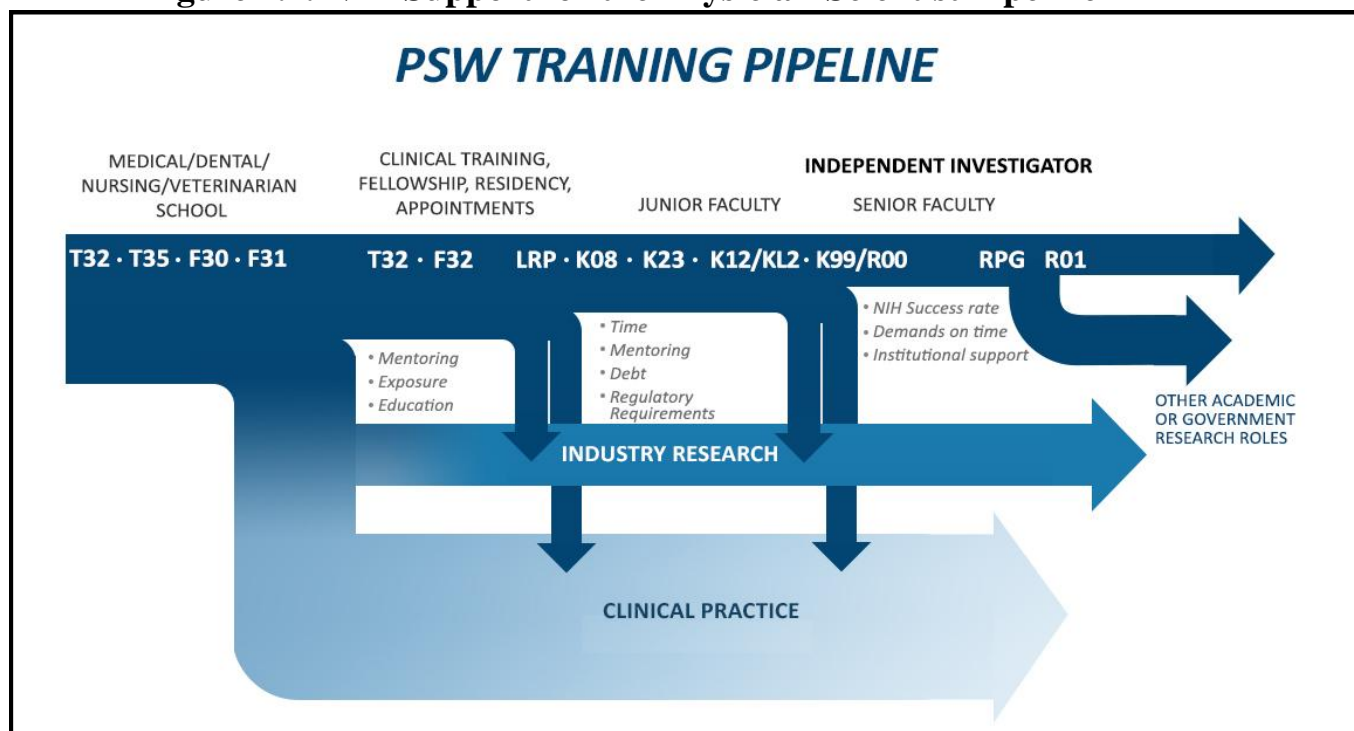
¹¹ Schafer, *ibid.*

informs clinical practice. While some nurse researchers conduct basic science to uncover the biological mechanisms of disease, the main focus of nursing research is minimizing the impact of disease on individuals, their families and caregivers, and communities.

NIH Support for the Development of the Physician-Scientist Workforce

NIH has provided support for the training and early career development of physician-scientists through a variety of funding mechanisms. Many of these award mechanisms are referenced throughout this report. Figure 2.2 illustrates the points of support provided along the physician-scientist pipeline, as well as the training/career stages in which individuals originally intent on a career modeled on their academic physician-scientist mentors find alternate paths. Figure 2.3 provides an overview of the major institutional and individual awards that appear in Figure 2.2.

Figure 2.2. NIH Support for the Physician-Scientist Pipeline¹²



Future Trends Affecting the Physician-Scientist Workforce

The Affordable Care Act

The Patient Protection and Affordable Care Act (PPACA, or ACA), signed into law by President Barack Obama in 2010, will have a significant impact on the delivery of health care services in the United States.

¹² Figure 2.2 is not drawn to scale, i.e., more physician-scientists are employed in clinical practice than in academic or industry research.

While some changes may pose threats to the physician-scientist workforce, others will create new opportunities.

Changes in reimbursement policies for the delivery of health care services under ACA will pose challenges for academic medical centers (AMCs), the traditional home of physician-scientists with a medical degree. These challenges include an increased number of patients with Medicaid, which traditionally has provided low reimbursement rates; a move away from fee-for-service medical care and a decrease in Medicare reimbursement for specialty services, both traditionally major sources of revenue and margin for AMCs; and threats to direct and indirect medical education payments, which fund costs of residents and faculty. As a result, AMCs will have fewer funds available internally to support physician-scientists and their research. Funding for physician-scientists in specialties such as surgery that have been relatively well compensated may be especially affected.

At the same time, new opportunities may arise for AMCs and physician-scientists. The emergence of population-health models, such as Accountable Care Organizations (ACOs), will create new opportunities for AMCs if they can master new organizational skills and re-position themselves in a competitive environment. Those AMCs that learn to manage costs successfully within population health risk models will earn profits that can help them invest in physician-scientists. Physician-scientists with expertise in areas such as clinical informatics, outcomes research, and economics will find important roles in AMCs responding to these new incentives, and new research funding sources, such as through the Patient Centered Outcomes Research Institute and the Centers for Medicare and Medicaid Innovation. Clinician scientists in diverse areas such as nursing, dentistry, and psychology may find their clinical and scientific skills increasingly valued by health systems that are increasingly responsible for patient outcomes and aware of the need for team approaches to care and research. Physicians in specialties that have historically been highly paid and anticipate declines in clinical earnings may be more likely to invest in training themselves for research and in maintaining research activity over their careers. Finally, at the Federal level, success in controlling costs could provide resources to increase investments in scientific research; the entire annual NIH budget is small compared to the increases in annual Medicare spending.

Team Science

The increasing complexity and specialization of modern research methods has led many to suggest a growing need for team science approaches in biomedical research.¹³ Team science provides opportunities for MD physician-scientists, nurse-scientists, dentist-scientists and veterinary-scientists, along with non-clinician PhDs, to work side-by-side in addressing health challenges, with more diffused and/or shifting leadership roles.

This new approach enables clinicians to have varying levels of percent effort involvement in science and thereby play an important role, while also maintaining their clinical, teaching, and administrative commitments. If the current “all or none” approach whereby a scientist is defined as having an individual R01 is de-emphasized in the future, this could draw more clinicians interested in participating in clinical or translational research back into the scientific workforce. However, shifting to a team science approach will require a major cultural shift in the promotion and tenure process, which has long been oriented toward individual achievement. This means new investigators may be jeopardizing their career

¹³ Bennet, L.M., Gadlin, H. & Levine-Findley, S. (2010). Collaboration and team science: A field guide. <http://ombudsman.nih.gov/collaborationTS.html>

advancement opportunities if they serve as key personnel, rather than principal investigator, on a grant. In addition, funding opportunities and training in team science leadership roles would need to be developed.

Figure 2.3. A Brief Primer on NIH Support for Physician-Scientists

Health Professional Training (http://grants.nih.gov/training/T_Table.htm):

T32 Institutional Training Grants: supports predoctoral and postdoctoral research training programs since 1974. Research training activities can be in basic biomedical or clinical sciences.

T35 Short-Term Institutional Training Grants: supports intensive, short-term research training experiences for health professional students (medical students, dental students, and/or students in other health-professional programs) during the summer.

Medical Scientist Training Program (MSTP)

(<http://www.nigms.nih.gov/Training/InstPredoc/Pages/PredocOverview-MSTP.aspx>):

Supports MD/PhD training programs at 43 institutions across the country, providing tuition and stipends to selected students for up to 6 years.

Fellowships (https://grants.nih.gov/training/F_files_nrsa.htm):

F32 Individual Postdoctoral Fellows: Applicants with a health professional doctoral degree may use the proposed postdoctoral training to satisfy a portion of the degree requirements for a master's degree, a research doctoral degree or any other advanced research degree program.

Career Development Awards (<http://grants.nih.gov/training/careerdevelopmentawards.htm>)

K08 Mentored Clinical Scientist Award: provides support and “protected time” to individuals with a clinical doctoral degree for an intensive, supervised research career development experience in the fields of biomedical and behavioral research, including translational research.

K23 Mentored Patient-Oriented Research Award: supports the career development of individuals with a clinical doctoral degree who have made a commitment to focus their research endeavors on patient-oriented research via a supervised research career development experience.

K99/R00 Pathway to Independence Award: facilitates a timely transition of outstanding postdoctoral researchers from mentored, postdoctoral research positions to independent, tenure-track or equivalent faculty positions, and provides independent NIH research support during the transition that will help these individuals launch competitive, independent research careers

Loan Repayment Program (http://www.lrp.nih.gov/about_the_programs/index.aspx): Encourages outstanding health professionals to pursue careers in biomedical, behavioral, social, and clinical research by repaying \$35,000 per year of student loan debt for up to 3 years for those employed in a research capacity.

Chapter 3

Physician-Scientists with a Medical Degree

Physician-scientists with a medical degree make unique contributions to biomedicine. From Alexander Fleming's discovery of penicillin in 1928 to Bruce Beutler's and Ralph Steinman's discoveries related to innate and adaptive immunity, for which they were awarded the Nobel Prize in 2011, MD physician-scientists have advanced human knowledge of disease and uncovered new treatments.

The importance of MD physician-scientists has been widely recognized:

- Over the last 25 years, **37 percent** of Nobel Laureates in Physiology or Medicine had an MD degree.
- Over the Lasker Awards' last 30 years, **41 percent** of the Basic Awards and **65 percent** of the Clinical Awards have gone to MDs.
- **69 percent** of NIH Institute Directors have an MD degree.
- **60 percent** of the National Academy of Sciences Class IV (Biomedical Sciences) members have an MD degree.
- **70 percent** of the chief scientific officers at the top 10 pharmaceutical companies have an MD degree.

This chapter summarizes the findings of the PSW-WG regarding the current composition of the MD, DO, and MD/PhD physician-scientist workforce, based on an analysis of data from multiple sources, including the NIH IMPACII data system, the American Medical Association, and the American Association of Medical Colleges, as well as focus groups discussions and interviews with early career physician-scientists.

Training of Physician-Scientists with Medical Degrees

Physician-scientists include those with a medical degree (MD or DO), as well as those with both MD and PhD degrees. Becoming an MD physician-scientist requires an investment of many years of training that begins in medical school, graduate school, or both, and typically proceeds through multiple years of specialty and subspecialty clinical and research training (residency/fellowship).

NIH supports the training of physician-scientists at several points during their training (see [Figure 2.2](#)). Institutional T32 grants support predoctoral and post-doctoral research training of health professionals; institutional T35 grants support intensive short-term research training for predoctoral students.

The largest group of NIH-funded US physician-scientists continue to be those who hold an MD as their only professional degree (see [Figure 2.1](#)). Of the 8,278 physician-scientists who held an NIH RPG award in 2012 (using a rolling 5-year window estimate, see [Figure 3.3](#)), 4,192 (50.6 percent) were MDs (without a PhD), with this group comprising 57.9 percent of first-time physician-scientist applicants for RPGs in 2012 ([Figure 3.6](#)) (and 57.8 percent of awardees from this pool). These trends have been stable for more than a decade, despite an ever-increasing number of graduates from MD/PhD programs, and despite the increasing debt burden of MDs outside of these programs.

MD/PhD physician-scientists are a heterogeneous group of individuals that includes those who pursued their degrees in series (including many who may have gone through medical education or research training outside the United States), as well as those who earned both degrees simultaneously through participation in a combined MD/PhD program, including those offered by an institution receiving Medical Student Training Program (MSTP) funds from the National Institute of General Medical Sciences (NIGMS). Disaggregating MD/PhDs into these various career paths was not possible for this workforce study, in part because matching individuals tracked within data sources on combined MD/PhD program graduates collected by non-NIH organizations to NIH data was limited by data availability and data quality. Nevertheless, information on NIH support for combined MD/PhD programs reveals some interesting aspects of this part of the MD/PhD physician-scientist workforce.

The NIGMS-sponsored Medical Student Training Program (MSTP) supports MD/PhD training through 43 participating programs currently, with a total of 932 trainees supported each year.¹⁴ In addition to the 43 MSTP-funded programs, there are approximately 34 active MD/PhD programs in the U.S. that do not receive NIGMS support. In 2013, 609 students entered an MD-PhD program, 444 (73 percent) admitted to programs with MSTP support.¹⁵ Students in MD/PhD programs can apply for individual F30, and in selected cases, F31, predoctoral fellowship awards, which typically provide support during the graduate phase of the program, but can also support completion of medical school after thesis research is completed. The Biomedical Workforce Working Group recommended that NIH expand the F30 and F31 to all NIH Institutes and Centers, and that occurred in March of 2014.¹⁶

MD/PhD trainees in the MSTP typically receive their PhDs in one of the biological or physical sciences. A very small number of MSTP MD/PhDs have received their PhD in a social science (e.g., economics), outcomes research, clinical informatics, or other field outside the biological or physical sciences.

MD/PhD programs commonly provide full or substantial tuition and stipend support for students. As a result, MD/PhD program graduates usually have far less student debt than other medical school graduates. The costs related to MD/PhD programs are high and MSTP T32 awards typically provide only 20-25 percent of total MD/PhD program expenses. As a result, medical schools use a combination of other NIH training and research grant dollars, philanthropic and, most prominently, institutional resources to fund students. An analysis in 2008 of outcomes data from 24 MD-PhD programs enrolling 43 percent of the then-current trainees showed that 67 percent were employed at academic medical centers and universities, 4 percent were working at research institutes such as the NIH, and 8 percent were employed in industry.¹⁷ Attrition from MSTP-funded MD/PhD programs is relatively low. The rate of obtaining the PhD (and presumably the MD as well) for individuals who were appointed to a NIGMS MSTP T32 training grant for the first time in 1980-1989 was approximately 88 percent.¹⁸ Consistent with the result from reference 17, 68 percent of graduates in that cohort became medical school faculty. Data on NIH RPG applications and awards are included later in Chapter 3.

NIH also provides support for MD/PhD training through the MD/PhD Graduate Partnership Training Program (<http://mdphd.gpp.nih.gov/>). The GPP represents a unique physician-scientist training model in which graduate training at the NIH is combined with medical school completed elsewhere. Students complete their thesis research at the NIH or through one of NIH's graduate partnership programs. They

¹⁴ <http://www.nigms.nih.gov/Training/InstPredoc/Pages/PredocOverview-MSTP.aspx>

¹⁵ 2013 MD-PhD matriculants from AAMC internal report

¹⁶ <http://grants.nih.gov/grants/guide/notice-files/NOT-OD-14-056.html> and <http://grants.nih.gov/grants/guide/notice-files/NOT-OD-14-066.html>

¹⁷ Brass, L.F., Akabas, M.H., Burnley, L.D., Engman, D.M., Wiley, C.A., & Andersen, O.S. (2010). Are MD-PhD programs meeting their goals? An analysis of career choices made by graduates of 24 MD-PhD programs. *Academic Medicine* 85(4):695-701.

¹⁸ Preusch, P. Personal communication.

then complete their MD education at an MSTP-associated medical school. Partial funding for medical school is provided through an additional training slot co-funded by the NIH institute in which the student performs his or her research. There have been 38 graduates of the program since 2007 and there are 46 current students. The majority of these students have done their PhDs in the NIH-Oxford-Cambridge Scholars program (<http://oxcam.gpp.nih.gov/>), in which students are co-mentored by investigators at NIH and either Oxford or Cambridge University in the U.K. Long term outcomes data from the GPP are not yet available; all of the program graduates are currently completing postgraduate residencies and fellowships.

To shorten the post-graduate training period for physician-scientists, Short-Track Programs are offered by various medical specialty boards. Physician-Scientist Training Programs (PSTP) are offered at several institutions. In these programs, the number of years in clinical specialty and subspecialty training are reduced to accommodate more training in clinical or laboratory-based research. Data from the American Board of Internal Medicine suggests that such short-track research residency programs are effective at developing physician-scientists. Surveys of 385 (of 813) participants who completed the American Board of Internal Medicine's 'short track' research pathway residency (1995-2007) revealed that:

- 91 percent are *currently* involved in research
- Mean percentage effort spend in research was 59 percent.¹⁹

During the late phases of fellowship training and initial employment as a faculty member or researcher, NIH supports early career investigators primarily through two mechanisms:

- K08/K23 awards that provide up to 5 years of mentored research experience.
- A Loan Repayment Program that repays up to \$35,000 per year of qualified student debt for biomedical researchers who commit for up to 3 years of research (the maximum repayment amount is currently \$105,000).

Research about Medical Students' Decisions to Pursue a Research Career

Qualitative research²⁰ conducted with MD/PhD students identified one striking difference between these students and the general medical student population: the MD/PhD students almost universally made a decision to enter a research career well before they entered medical school, often as early as middle school and/or high school. They spoke of being exposed to grandparents or parents who were scientists, encountering physician-scientists during a health crisis of their own, or being excited by a high school biology teacher. They spoke of mentors they encountered during science courses in their undergraduate studies that convinced them that this career path was possible.

Similarly, interviews with deans at medical schools reported that students at their schools who expressed an interest in research typically developed that interest prior to their arrival in medical school. One dean suggested that the most important strategy to strengthen the biomedical workforce would be to foster students' natural curiosity and excitement about science beginning in elementary school.

Nonetheless, exposure to research during medical school increases students' interest in research. Students graduating from medical school express more interest in research than students entering medical school, according to an AAMC study of students between 2006-2010. In this study, only 2.5 percent of students

¹⁹ Todd R.F., Salata R.A., Klotman M.E, et al. (2013). Career outcomes of the graduates of the American Board of Internal Medicine Research Pathway, 1995-2007. *Academic Medicine*, 88(11):1747-1753.

²⁰ Appendix V contains a summary of qualitative research conducted to inform this PSW-WG

expressed an interest in research when they entered medical school; that percentage had increase to 16.4 percent upon graduation. Further, approximately 45 percent of medical school graduates expect to be “somewhat involved” in research during their careers.²¹

Medical students from underrepresented racial/ethnic backgrounds who participated in the qualitative research indicated that they never considered a career in research because they knew nothing about it, having never encountered a physician-scientist as they were growing up. This point underscores the critical role of mentorship for both students and faculty.²² Recent reports have emphasized an intrinsic bias against women and minorities in mentoring as contributing to the disparities.^{23,24}

Financial pressures on these students reduced their interest in pursuing lengthy training in addition to obtaining an MD degree, as did the lower salaries they would earn as researchers. These students advocated for more programs that gave promising minority students exposure during high school and college to physician-scientists and to biomedical research.²⁵

Paik, Howard, & Lorenz analyzed graduate placement data from NIH-funded MSTP programs from 2004 to 2008. They reported that the most common residencies for MSTP graduates were internal medicine (24.6 percent), pathology (10.3 percent), pediatrics (10 percent) and diagnostic radiology (6.9 percent). MSTP graduates were least likely to enter residencies in family medicine, emergency medicine, and obstetrics/gynecology.²⁶ A 2013-2014 survey of MD/PhD trainees by the American Physician Scientists Association yielded similar results. Brass, et al. found in a 2010 review of 4 decades of outcomes data that nearly all (95 percent) MD/PhD program graduates enter clinical residencies. They also found that the proportion of graduates choosing clinical training in internal medicine, pediatrics, pathology and neurology declined from 73 percent for the 1965-1978 cohort to 57 percent for the 1999-2007 cohort.²⁷

Size and Composition of the Physician-Scientist Workforce in 2012

Using a definition of research as the self-reported primary activity, data from AMA annual surveys show that the overall size of the segment of the physician-scientist workforce with a medical degree has experienced a small but statistically significant decline over the past ten years from 14,521 in 2003 to 13,717 in 2012. In 2012, physician-scientists comprised 1.5 percent of the total physician workforce. Of particular concern is the aging of the workforce and persistent patterns of unequal participation by women and racial/ethnic minorities.

²¹ Courtesy of Ann Bonham, AAMC

²² Merchant J.L. & Omary M.B. (2010). Under representation of underrepresented minorities in academic medicine: The need to enhance the pipeline and the pipe. *Gastroenterology*, 138, 19-26

²³ Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M., & Handelsman, J. (in press, published online ahead of print). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences*, 109, 16474-16479.;

²⁴ Milkman, K.L., Akinola, M. & Chugh, D. (2012). Temporal distance and discrimination: An audit study in academia *Psychological Science* 23(7), 710-717.

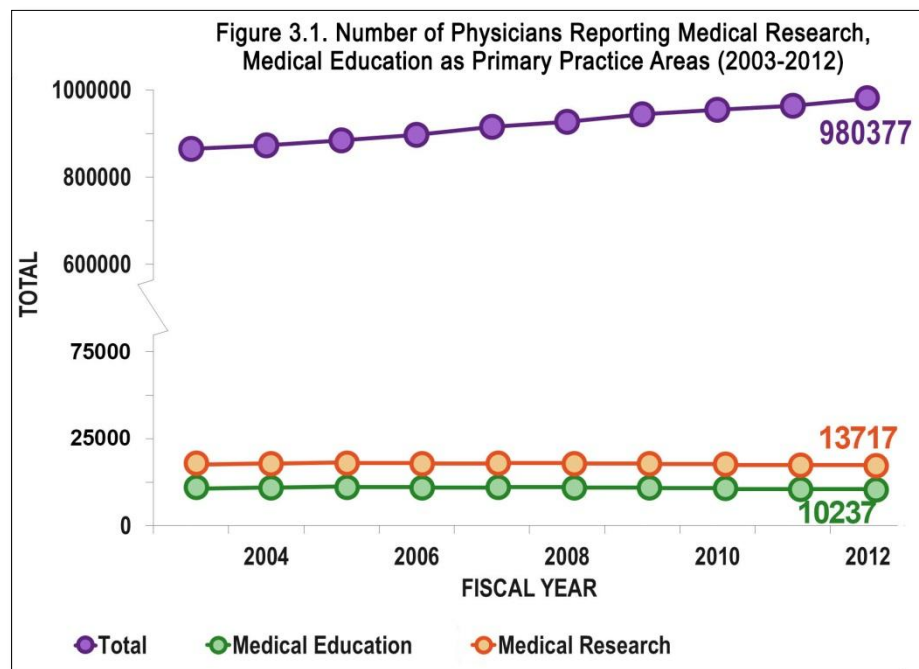
²⁵ Of note, substantial efforts in this area are already in place through organizations such as Annual Biomedical Research Conference for Minority Students (ABRCMS), Society for Advancement of Chicanos and Native Americans in Science (SACNAS), the National Science Foundation, and the Ivy Plus consortium of universities, as well as the NIH-sponsored MARC U-STARs program that provides support for undergraduate students who are underrepresented in the biomedical and behavioral sciences to improve their preparation for high-caliber graduate training at the PhD level.

²⁶ Paik, J.D., Howard, G., & Lorenz, R.G. (2009). Postgraduate Choices of Graduates from Medical Scientist Training Programs, 2004-2008. *Journal of the American Medical Association*, 302(12), 1271-1273.

²⁷ Brass et al, *ibid*.

Key findings include:

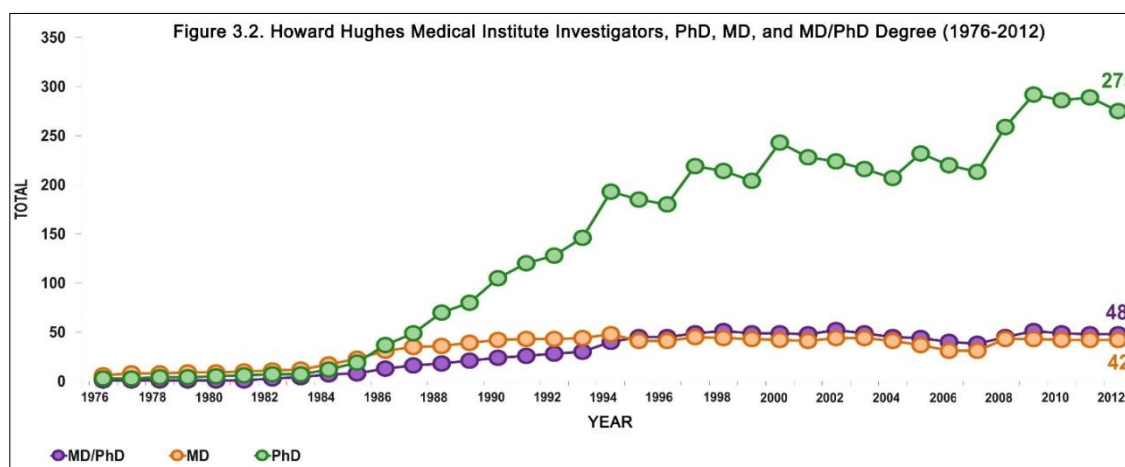
- There were 13,717 physicians with research self-reported as their primary activity in 2012 (Figure 3.1). The number of self-reported physician-scientists has declined from an average of 14,467 (2003-2005) to an average of 13,676 (2010-2012), ($p < 0.0001$)



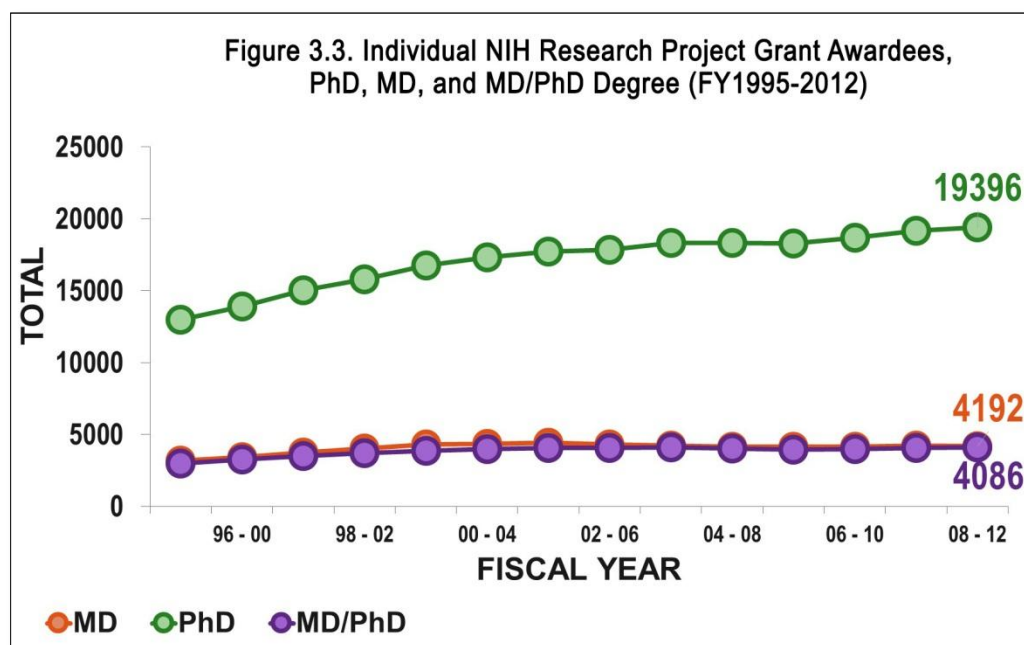
SOURCE: Those MD-holding Physicians that indicated they were in primarily Medical Education or Medical Research from the American Medical Association (AMA) Physician Masterfile Annual Year-end Snapshots.

- In September 2013, of the 1,176 intramural researchers employed by the NIH, 692 (59 percent) had PhDs, 295 (25 percent) had MDs and 168 (14 percent) had MD/PhDs.
- There are approximately 1800 funded clinician investigators working for the Veterans Administration (VA), of whom 82 percent are MDs, 15 percent are MD/PhDs, and 3 percent are RN/PhDs. There is also one DVM/PhD, but no DVM-only or dentist-scientists. Physician-scientists who work at the VA may also have NIH RPGs that are administered through an academic affiliate or the VA nonprofit corporation.²⁸ The number of these "dually funded" individuals is currently unknown.
- From 1976-1985, ~60-70 percent of Howard Hughes Medical Institute (HHMI) investigators were MDs (~ 1/4 MD/PhDs). Since that time, the total number of HHMI investigators has increased from 50 to the current 371, with a gradual decline in the percentage of MDs. In 2012, of the 371 HHMI investigators, only 92 (24.8 percent) are physician-scientists (42 MDs and 48 MD/PhDs). This pattern (as shown in Figure 3.2 below) is very similar to the change in NIH RPG awards by degree over the similar timeframe.

²⁸ M. Cody (personal communication, April 22, 2014)



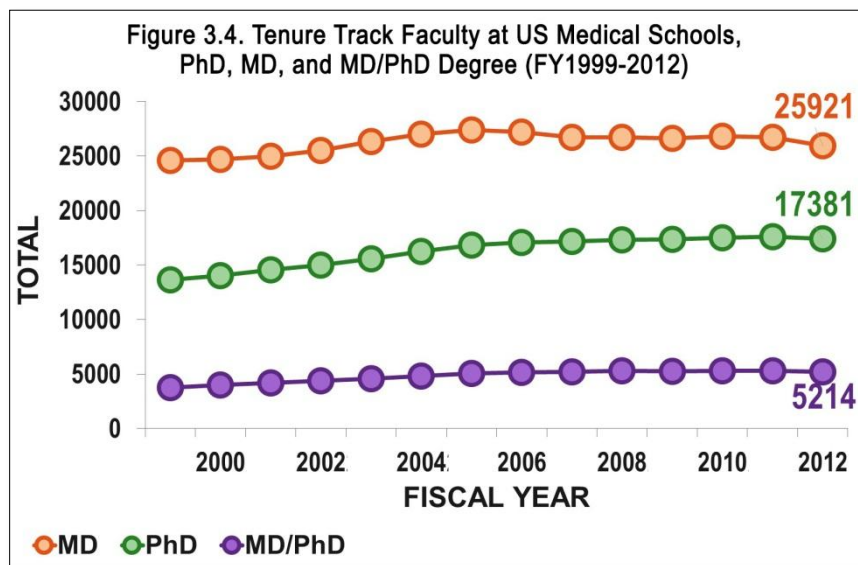
- Accurate numbers regarding the number of physician-scientists in biotechnology and pharmaceutical companies are not currently available.
- 4,192 MDs and 4,086 MD/PhDs held NIH RPG awards during the 5-year period 2008-2012, as shown in Figure 3.3.²⁹



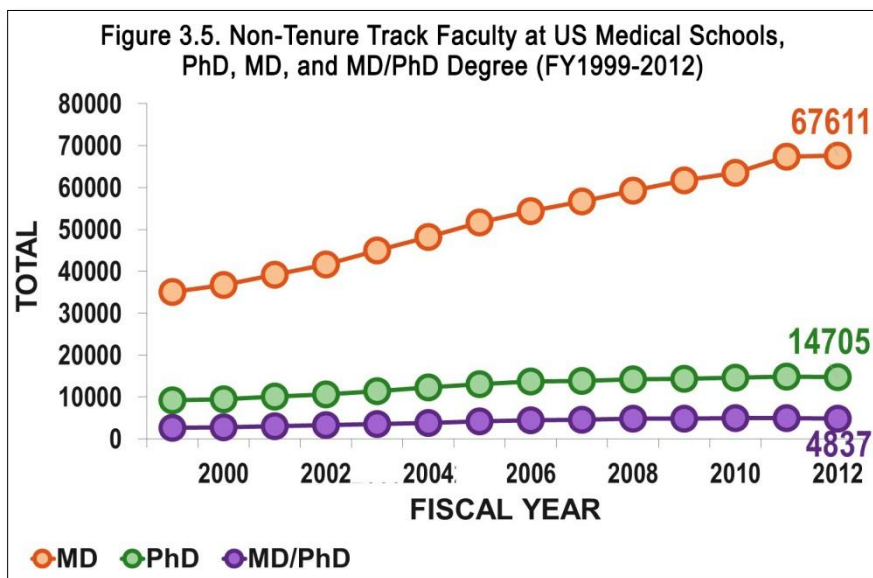
Data were aggregated over 5 year windows to reduce double counting of individuals who apply multiple times or were awarded multiple grants during that window.

²⁹ Other than in a few select graphs, the data presented in this report are for Research Project Grants (RPG) applicants and awardees. Similar analyses for R01 grants may be found in Appendix IV.

- 25,921 MDs and 5,214 MD/PhDs are tenure-track faculty at U.S. medical schools (Figure 3.4).



- 67,611 additional MDs and 4,837 additional MD/PhDs are non-tenure track faculty at medical schools, as displayed in Figure 3.5.



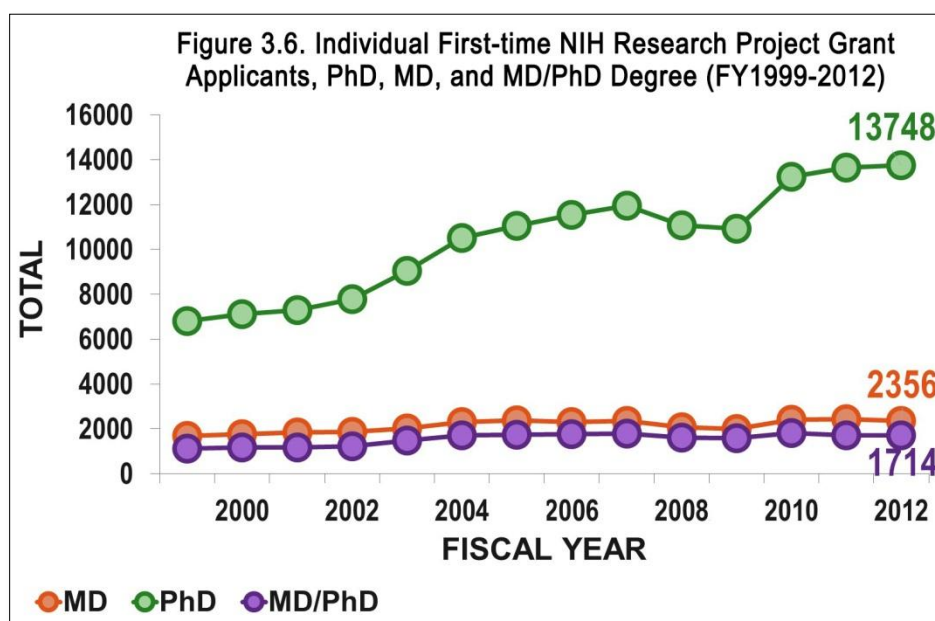
- The vast majority of physician-scientists (whose primary affiliation is at a medical school) with NIH RPGs are on the tenure track. In 2012, for example, 72 percent of the RPGs awarded to MDs at U.S. Medical Schools went to individuals on the tenure track; for MD/PhDs, 84 percent of RPGs went to those on the tenure track.

Physician-Scientists with a Medical Degree in the NIH-Funded Workforce

As noted in the previous section, about 8,000 of the 14,000 physician-scientists in the United States have Research Project Grants (RPG) from NIH. This section examines the patterns of RPG applications and funding, as well as the impact of NIH early career awards on the careers of these physician-scientists. Note that unless otherwise stated in the text, “MD/PhD” includes individuals who were trained in combined MD/PhD programs, as well as individuals who obtained their degrees sequentially in the U.S. or elsewhere.

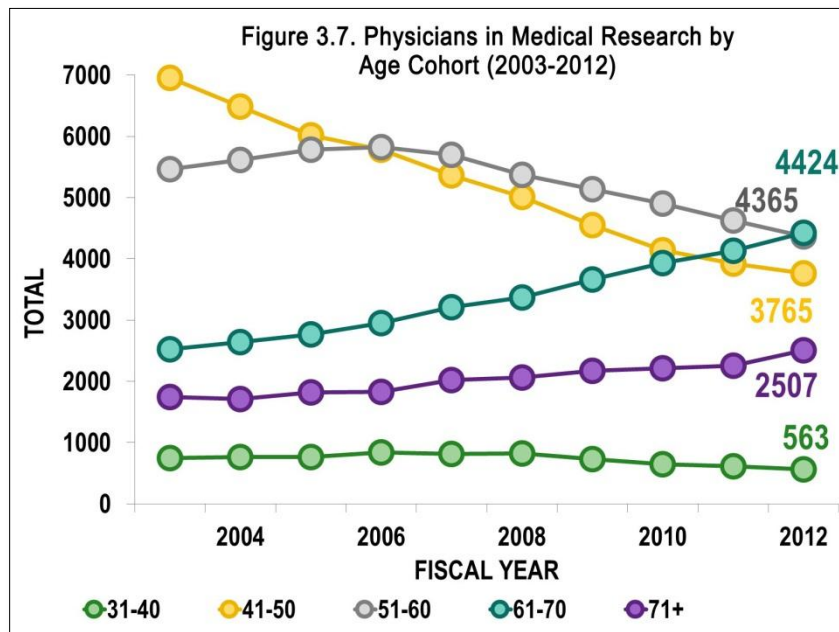
Physician-Scientist Application and Award Patterns

- Numbers of **First Time RPG Applicants** for MDs (2,356 in 2012) and MD/PhDs (1,714 in 2012) have been stable for 10 years, despite declining award rates (Figure 3.6). During the same period, however, there was a near doubling in the number of first time applicants for PhDs (7,785 in 2002, vs. 13,748 in 2012). The growth of new physician-scientists has therefore not kept pace with that of PhDs.



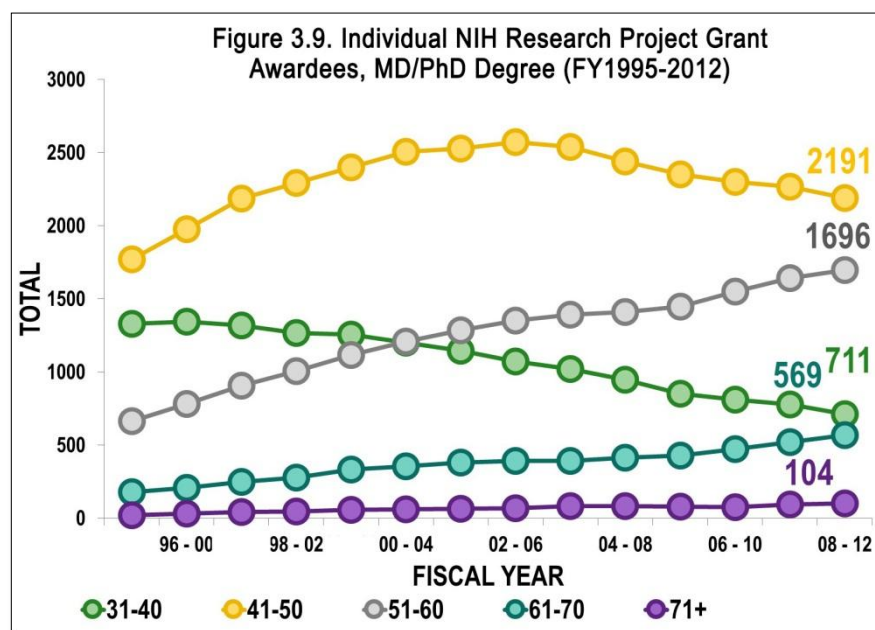
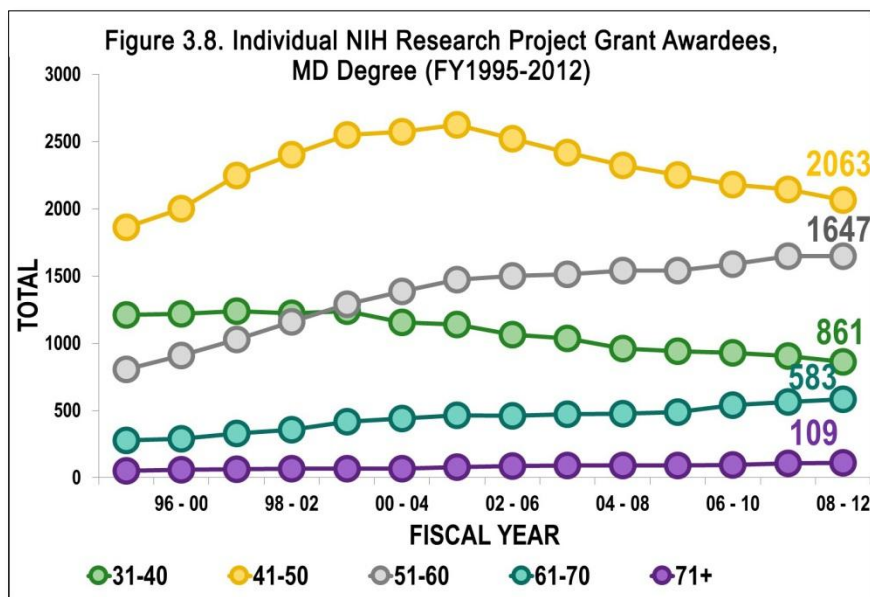
Age

- The average time to degree in MD/PhD programs is currently 8 years, and the average time from graduation to the first RPG is 13 years. For MDs, the average time from medical school graduation to the first RPG is currently 17 years.
- The age profile of the physician-scientist workforce has increased slowly over the past decades, as seen in Figure 3.7. There was a decline in the number of individuals from the ages of 31-60, and an increase in individuals over the age of 60.

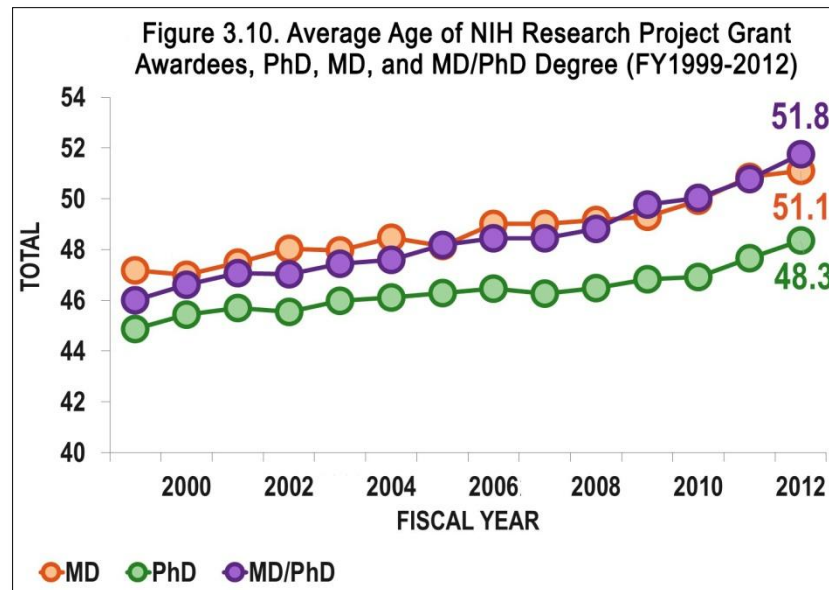


SOURCE: Those MD-holding Physicians that indicated they were in primarily Medical Education or Medical Research from the American Medical Association (AMA) Physician Masterfile Annual Year-end Snapshots.

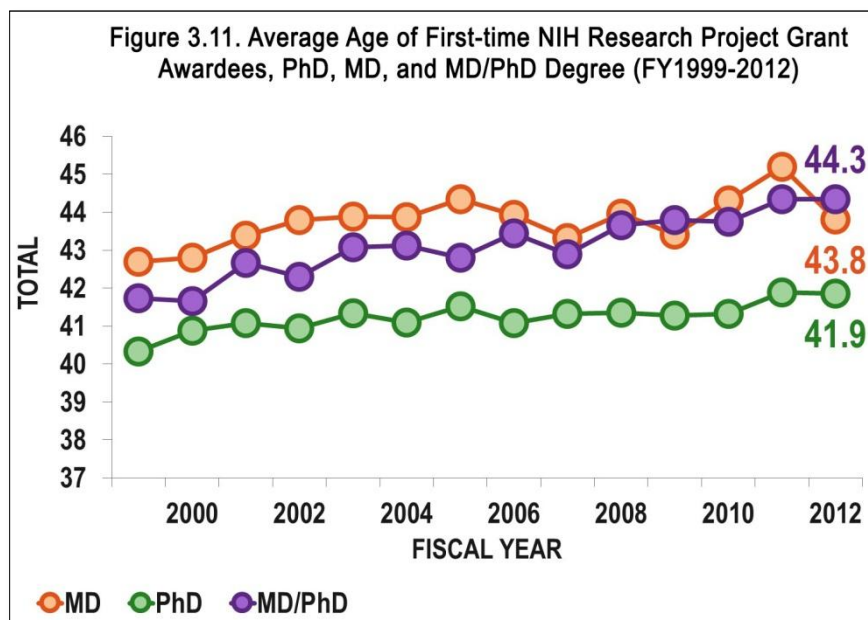
- The average age of physician-scientists with NIH RPGs has slowly increased over the past decade (Figures 3.8 and 3.9). There was a decline in individuals from the ages of 31-50, and growth in grant holders over the age of 50.



- The average age of MD RPG grant holders was 48 in 2003, and 51 in 2012; the average age for MD/PhDs with RPGs was 48 in 2003 and 52 in 2012; and for PhDs, 46 in 2003 and 48 in 2012. See Figure 3.10 for a graphic display of these findings.



- In 2012, the average age of **First Time** RPG awards for MDs was 43.8 years, for MD/PhDs, 44.3 years, and for PhDs, 41.9 years (Figure 3.11).



Gender

U.S. Medical Schools matriculants and applicants:

- The percentage of female medical student matriculants peaked at 49.6 percent of U.S. medical school students in 2003 and has shown slight decreases in subsequent years.³⁰
- There have been small decreases in the percentage of women applicants into medical school since 2003-2004, however, the total number of women applicants increased to a high of 20,780 in 2011-2012.³¹

MD degrees

- In 1982-83, 26 percent of MD degrees in U.S. Medical Schools were awarded to women and in 2010-2011, 48.4 percent.³²
- The percentage of female MDs who are RPG grant holders has increased from 17 percent in the mid-1990s to 29 percent currently. However, for MD/PhDs, growth has been considerably slower, increasing from 17 percent in the mid-1990s to only 22 percent at the present time, reflecting a more persistent disparity in gender for this group.

MD/PhD degrees:

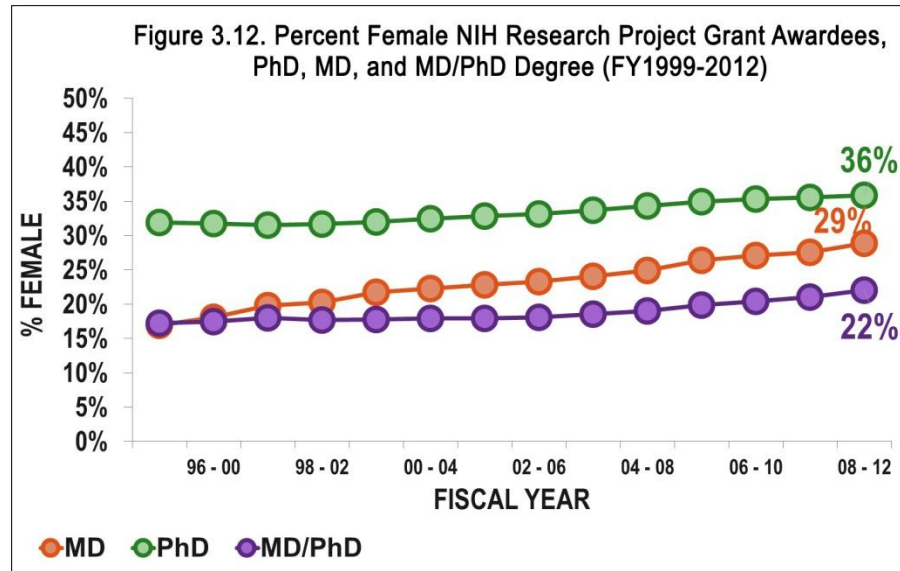
- There remains a disparity in the percentage of male and female students of MD/PhD programs U.S. Medical Schools. In 2011, 39 percent of applicants, 37 percent of matriculants, and 42 percent of graduates were women. From 2001 to 2011, the percentage of female MD/PhD graduates increased from 30 percent to 42 percent.³³

³⁰ Association of American Medical Colleges. (2012, March). Analysis in brief: The changing gender composition of U.S. medical school applicants and matriculants.12 (1). Retrieved from https://www.aamc.org/download/277026/data/aibvol12_no1.pdf (Association of American Medical Colleges U.S. medical school applicants and students 1982-1983 to 2011-2012, Retrieved, from <https://www.aamc.org/download/153708/data/>

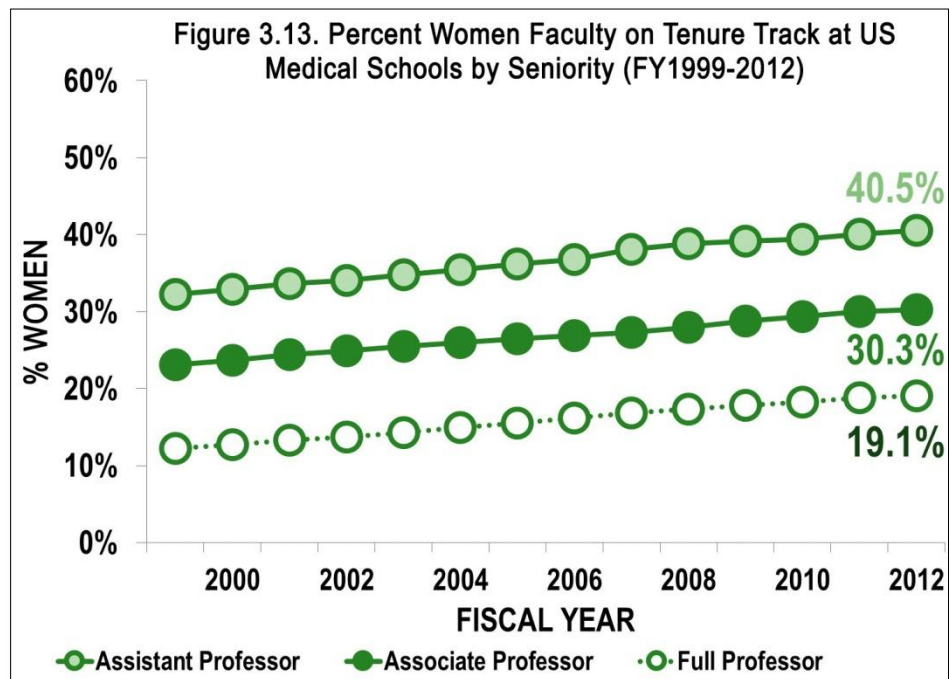
³¹ [AAMC](#) (2012, March), *ibid*.

³² Association of American Medical Colleges. U.S. medical school applicants and students 1982-1983 to 2011-2012, Retrieved from <https://www.aamc.org/download/153708/data/>

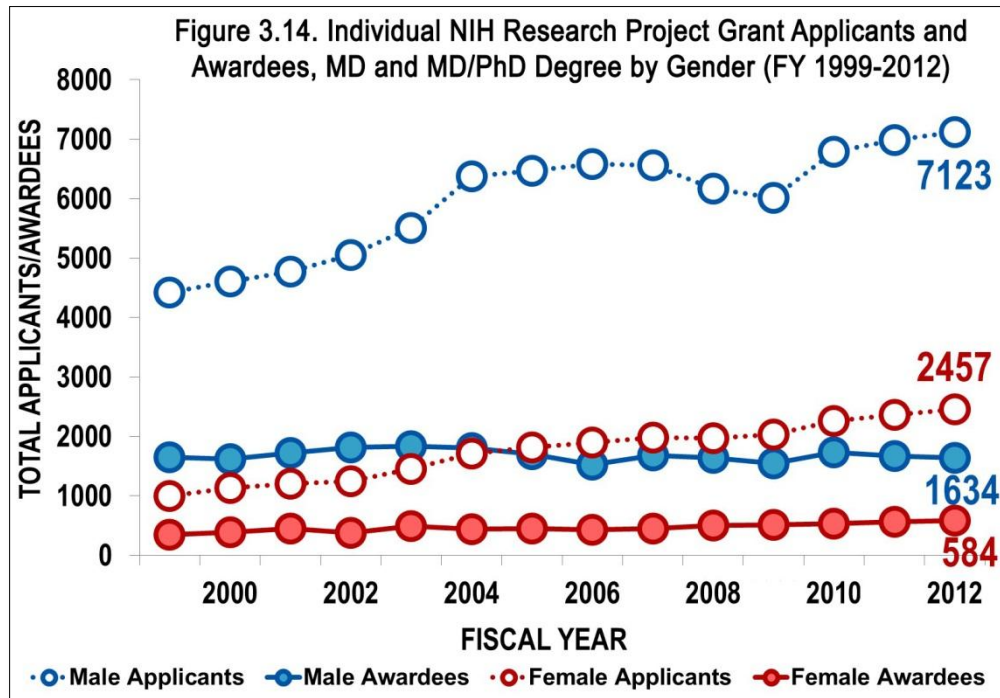
³³ Association of American Medical Colleges. (2012, December) Table 32: MD-PhD applicants, acceptees, matriculants, and graduates of U.S. medical schools by sex, 2001-2012. Retrieved, from <https://www.aamc.org/download/321542/data/2012factstable32.pdf>



- Although the percentage of male and female medical school students and of instructor-level faculty have become nearly equal, the gender gap is greater with higher academic ranks⁴. However, the gender gap is slowly narrowing for all academic ranks, as seen in Figure 3.13.



- The NIH RPG award rates in 2012 were not significantly different for men and women (men 22.9 percent, women 23.8 percent, $p=0.115$). There were also no significant differences in award rates by gender with any degree type (for MDs, 21.2 percent vs. 23 percent, $p=0.1571$; for MD/PhDs, 24.6 percent vs. 24.8 percent, $p=0.8918$; for PhDs, 21.8 percent vs. 20.9 percent, $p=0.0959$). However, large differences in the number of male and female applicants persist, although the gap is slowly closing (women were 26 percent of RPG applicants holding MDs and MD/PhDs in 2012, compared to 18 percent in 1999) (Figure 3.14).



Race/Ethnicity³⁴

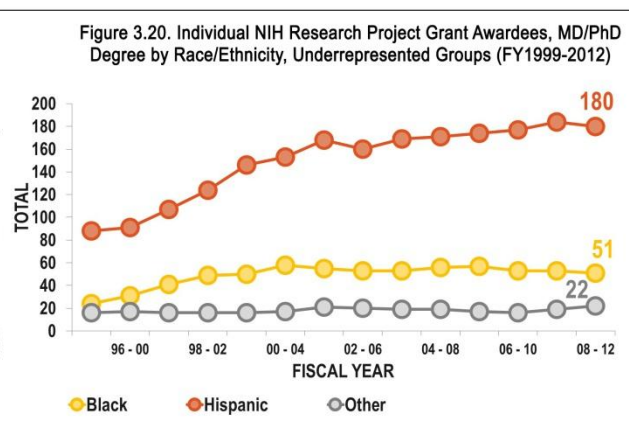
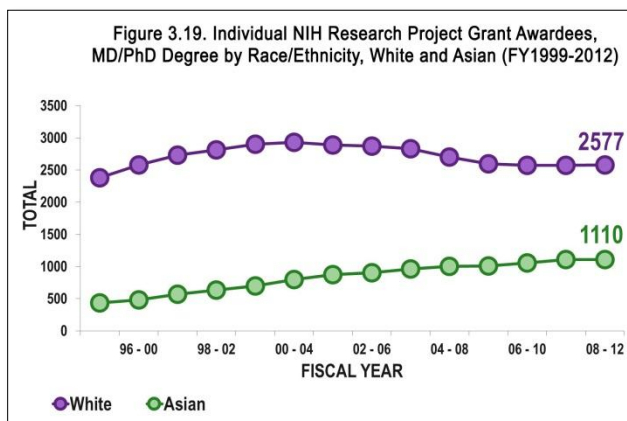
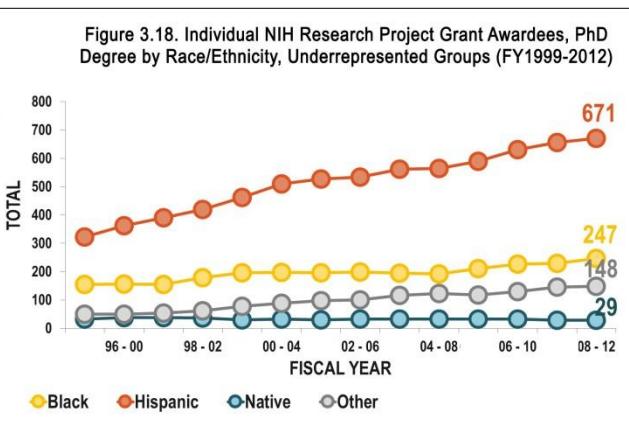
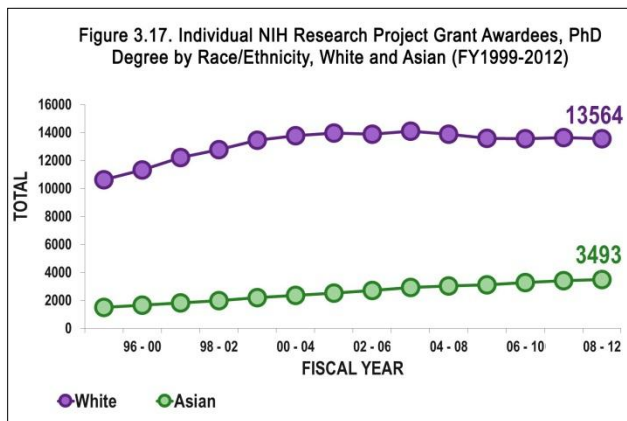
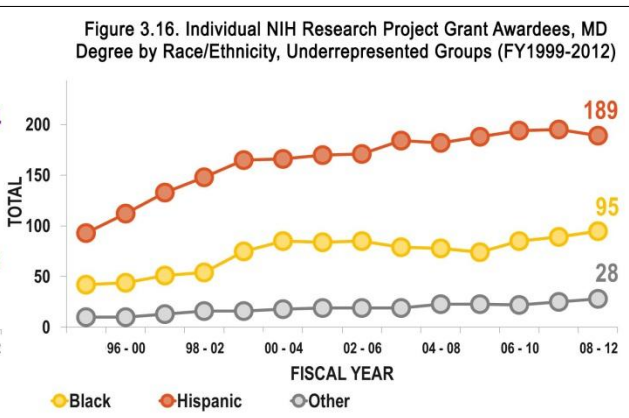
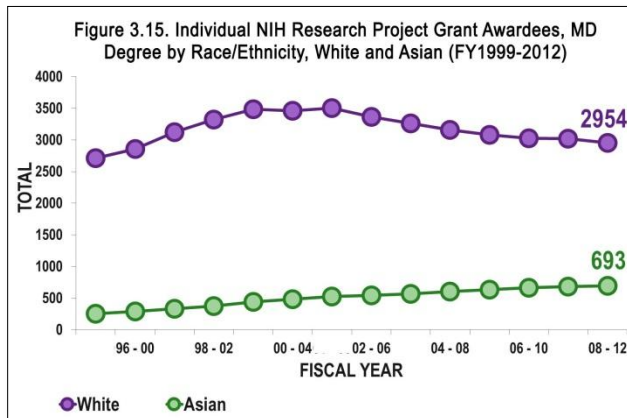
Figures 3.15 through 3.20³⁵ illustrate the following findings:

- The RPG applicant pool in 2012 included 22,635 Whites (69.5 percent of the total applicant pool), 7,403 Asians (22.7 percent), 1,469 Hispanics³⁶ (4.5 percent), 768 African Americans (2.4 percent), and 56 Native Americans (0.17 percent).
- The RPG awardee pool in 2012 included 5,310 Whites (73.6 percent of the total awardee pool), 1,458 Asians (20.2 percent), 261 Hispanics (3.6 percent), 120 African Americans (1.7 percent), and 10 Native Americans (0.13 percent).
- RPG award rates for underrepresented race/ethnic minorities in 2012 were lower than that of white applicants (Whites, 23.5 percent; Asians, 19.7 percent, $p < 0.002$; African-Americans, 15.6 percent, $p < 0.002$; Hispanics, 17.7 percent, $p < 0.002$; Native Americans, 17.8 percent, $p = 0.3232$).
- Although there has been significant growth for Asian and Hispanic awardees over the past decade, there has been less growth for African-Americans and Native Americans. The proportion of white awardees is shrinking.
- In 2012, the PhD RPG awardee pool included 3,703 Whites (74.9 percent), 954 Asians (19.3 percent), 166 Hispanics (3.4 percent), 76 African Americans (1.5 percent), and 7 Native Americans (0.14 percent).
- In 2012, the MD RPG awardee pool included 750 Whites (74.0 percent), 183 Asians (18.1 percent), 47 Hispanics (4.6 percent), 26 African Americans (2.6 percent), and 2 Native Americans (0.2 percent).
- In 2012, the MD/PhD RPG awardee pool included 763 Whites (68.4 percent), 291 Asians (26.1 percent), 36 Hispanics (3.2 percent), 14 African Americans (1.3 percent), and 1 Native Americans (<0.2 percent).

³⁴ Country of Origin was not factored into the Race/Ethnicity categorization.

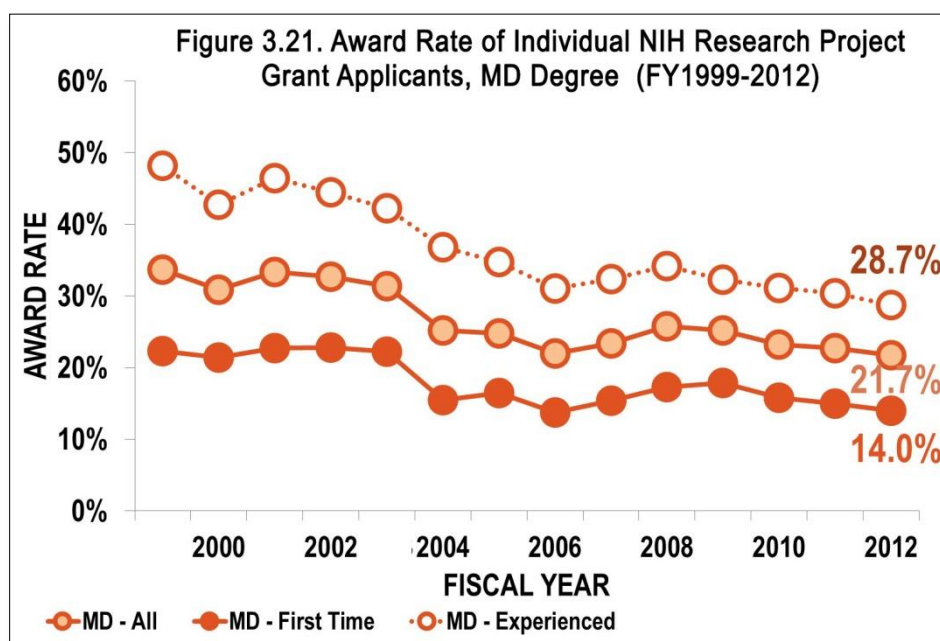
³⁵ In Figures 3.16 and 3.20, the annual number of Native American awardees was less than 10. Therefore, per NIH guidelines on privacy, the line representing this demographic group is not included on these graphs.

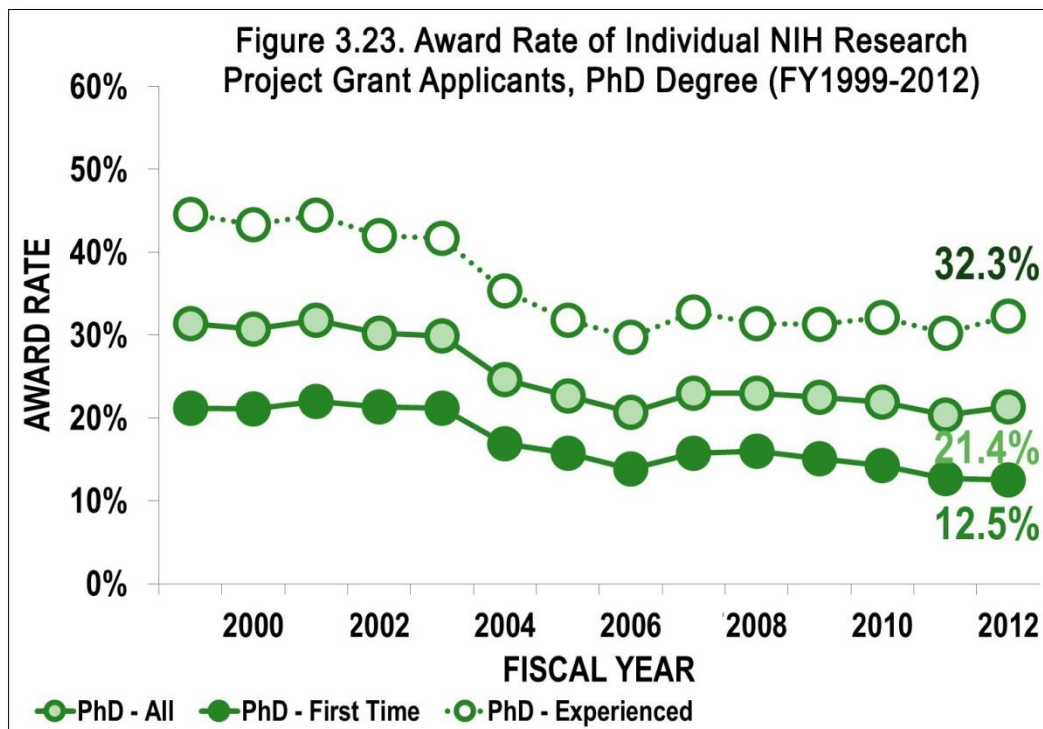
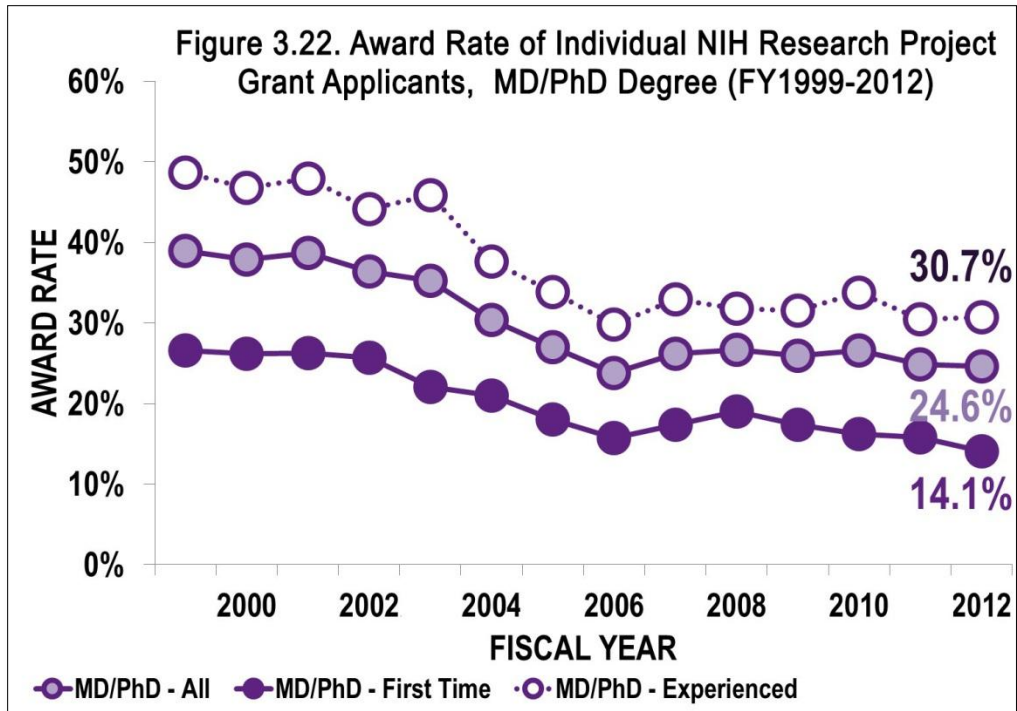
³⁶ For the purposes of this workforce analysis, it was necessary to have individuals categorized into one and only one Race/Ethnicity category. Individuals who reported both a non-White race (e.g. Native American) and Hispanic ethnicity were categorized as the reported Race (e.g. Native American). Individuals who reported White race and Hispanic ethnicity were categorized as Hispanic.



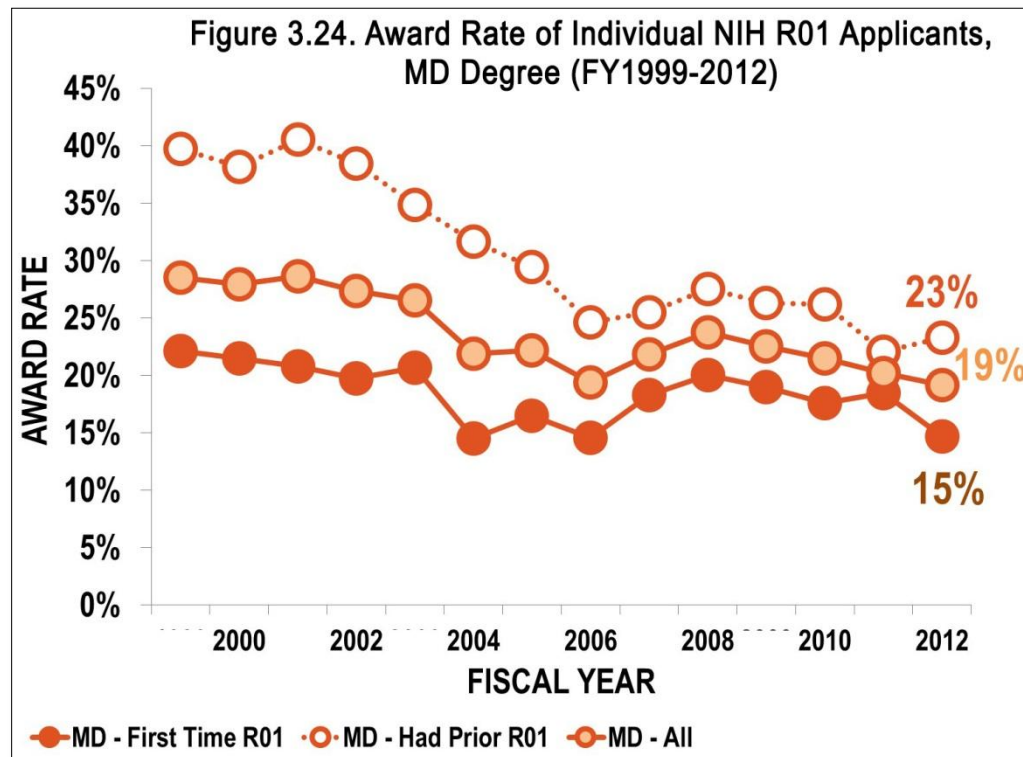
NIH RPG Award Rates by Degree Type and Experience

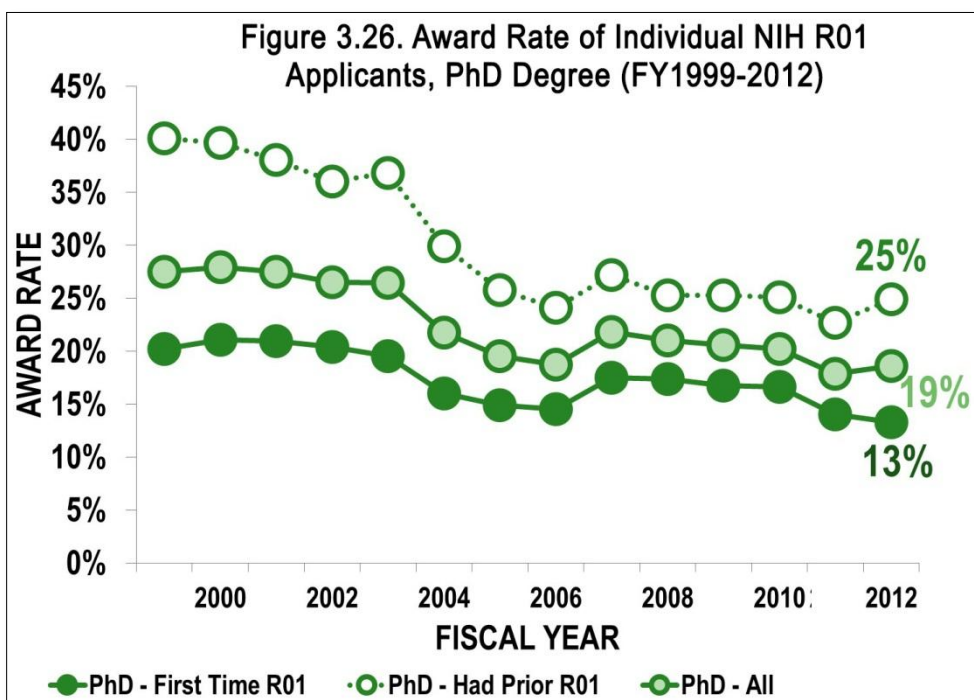
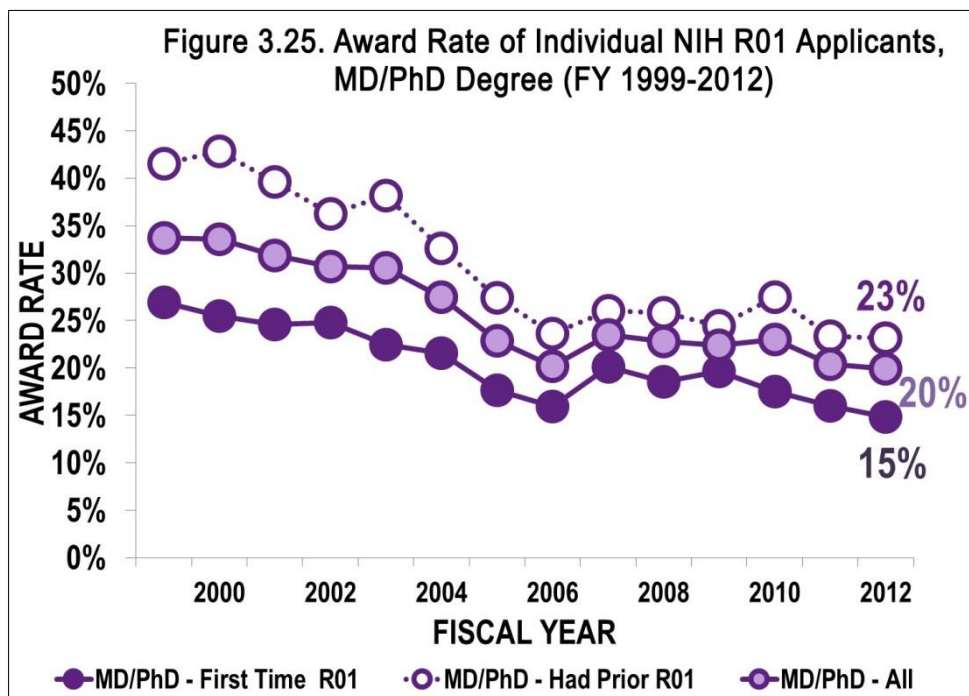
- In 2012, MD/PhDs overall had higher award rates for RPGs (24.6 percent) than MDs (21.7 percent, $p < 0.01$) or PhDs (21.4 percent, $p < 0.01$) (Figures 3.21 to 3.23).
- Experienced investigators have much higher award rates than first-time RPG applicants. In 2012, the award rate for MD/PhDs with a prior RPG was 30.7 percent; without a prior RPG, it was 14.1 percent. The award rate for MDs with a prior RPG was 28.7 percent; without a prior RPG, it was 14 percent. The award rate for PhDs with a prior RPG was 32.3 percent; without prior RPG it was 12.5 percent ($p < 0.0002$ for all three groups).





- However, for R01 applications, the difference in the gap between first-time and experienced investigators has narrowed in recent years (Figure 3.24-3.26). This reduction is likely due in part to NIH's New Investigator policies implemented in 2007 and strengthened in 2009. In 2012, the award rate for MD/PhDs with a prior R01 was 23.3 percent; without a prior R01, it was 14.9 percent. The award rate for MDs with a prior R01 was 23.3 percent; without a prior R01, it was 14.7 percent. The award rate for PhDs with a prior R01 was 24.9 percent; without prior R01 it was 13.3 percent ($p < 0.001$ for all three groups). See Figures 3.24 through 3.26 for graphic illustrations of these findings.



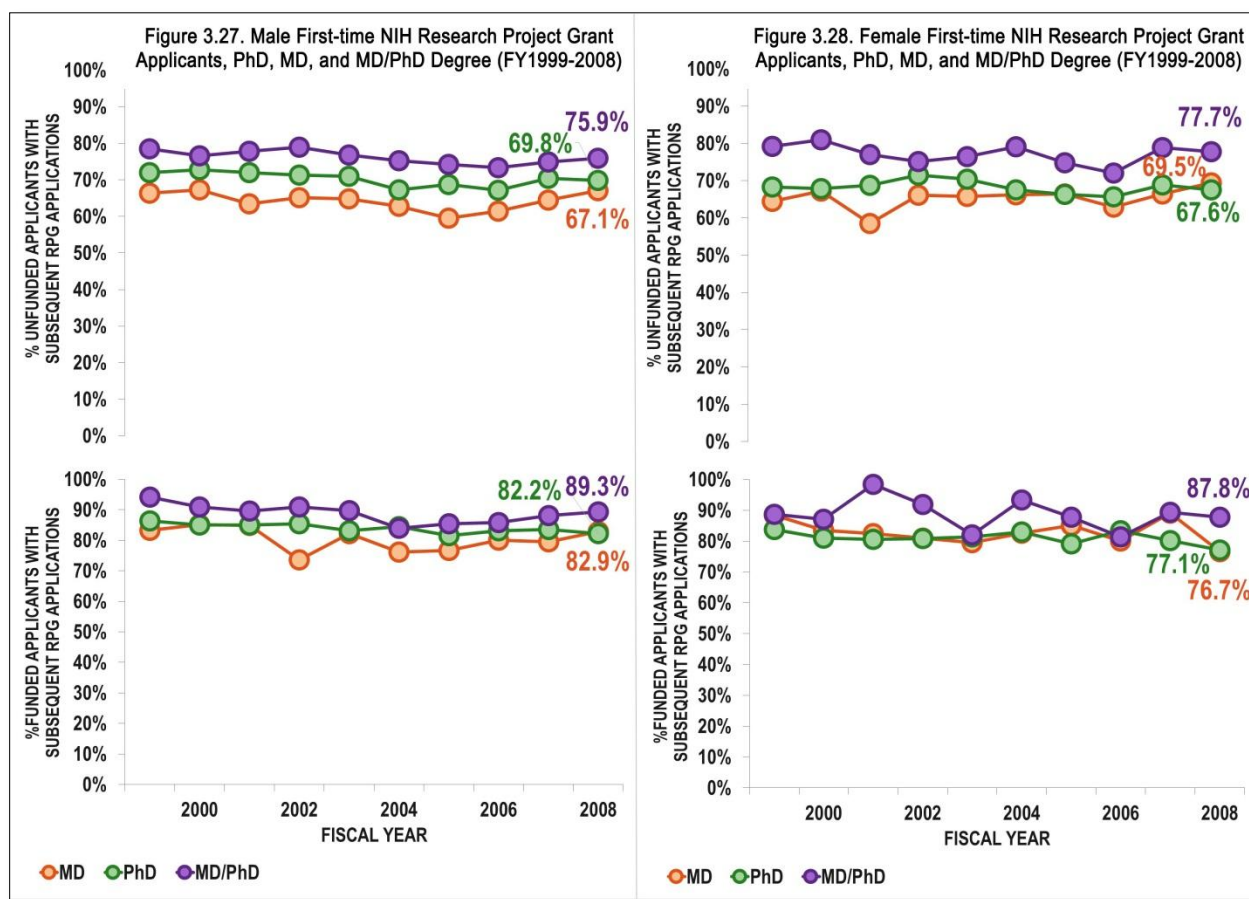


Persistence Quality by Degree and Gender

In Figure 3.27 below, the upper panels show the percentages of First-Time RPG applicants whose initial application in that fiscal year was not funded, but who re-applied for NIH RPGs in subsequent years. This analysis shows that a high percentage of the physician-scientist workforce persists in applying for NIH RPGs despite an unsuccessful first attempt.

The lower panels show the percentages of first time awardees by fiscal year who re-applied for NIH RPGs in subsequent years. Receipt of an NIH award slightly increased the persistence of the physician-scientists, as a higher percentage of awardees reapplied in later years compared to unsuccessful applicants.

Interestingly, MD/PhDs were generally more persistent than MDs (75.9 percent of male MD/PhD applicants in 2012 persisted compared to 67.1 percent of male MD applicants). There did not appear to be significant differences in persistence by gender.



Effects of Early Career NIH Programs on Physician-Scientists with a Medical Degree

- In 2012, 1,630 MDs and 365 MD/PhDs were appointed to Postdoctoral Training appointments under a T32 grant. Only 20 MDs and 9 MD/PhDs were awarded Postdoctoral F32 Fellowships. Additional information about trends of postdoctoral fellowships and training appointments maybe found in [Appendix IV](#).
- Analysis of a cohort of individuals who received their first postdoctoral appointment to a T32 grant between 1999 and 2008 shows that only one-quarter subsequently applied for an RPG. While half of those who applied were successful, only 10 percent of those with a T32 appointment subsequently received an RPG (Table 3.1 below).³⁷

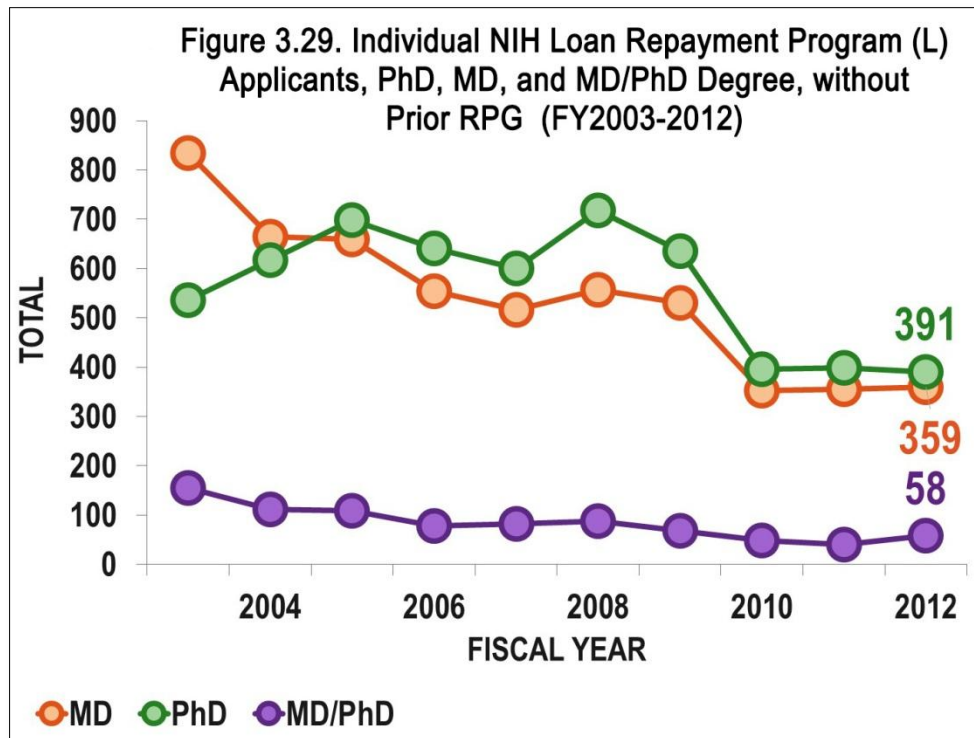
Table 3.1. RPG Applications and Awards Among T32 Postdoctoral Appointees, 1999-2008

	T32 appointees (1999-2008)	T32 appointees that applied RPG	Percentage T32 appointees that applied RPG	T32 appointees that were awarded RPG	Percentage T32 appointees that were awarded RPG	Award rate of T32 appointees applying RPG
Female	13607	3016	22.20%	1354	9.95%	44.89%
Male	14188	3484	24.60%	1756	12.38%	50.40%
MD	9897	1549	15.70%	719	7.26%	46.42%
PhD	15280	4104	26.90%	1929	12.62%	47.00%
MD/PhD	1109	355	32.00%	211	19.03%	59.44%
	T32 appointees (1999-2008)	T32 appointees that applied R01	Percentage T32 appointees that applied R01	T32 appointees that were awarded R01	Percentage T32 appointees that were awarded R01	Award rate of T32 appointees applying R01
Female	13607	1900	13.96%	766	5.63%	40.32%
Male	14188	2456	17.31%	1217	8.58%	49.55%
MD	9897	1059	10.70%	495	5.00%	46.74%
PhD	15280	2659	17.40%	1189	7.78%	44.72%
MD/PhD	1109	281	25.34%	143	12.89%	50.89%

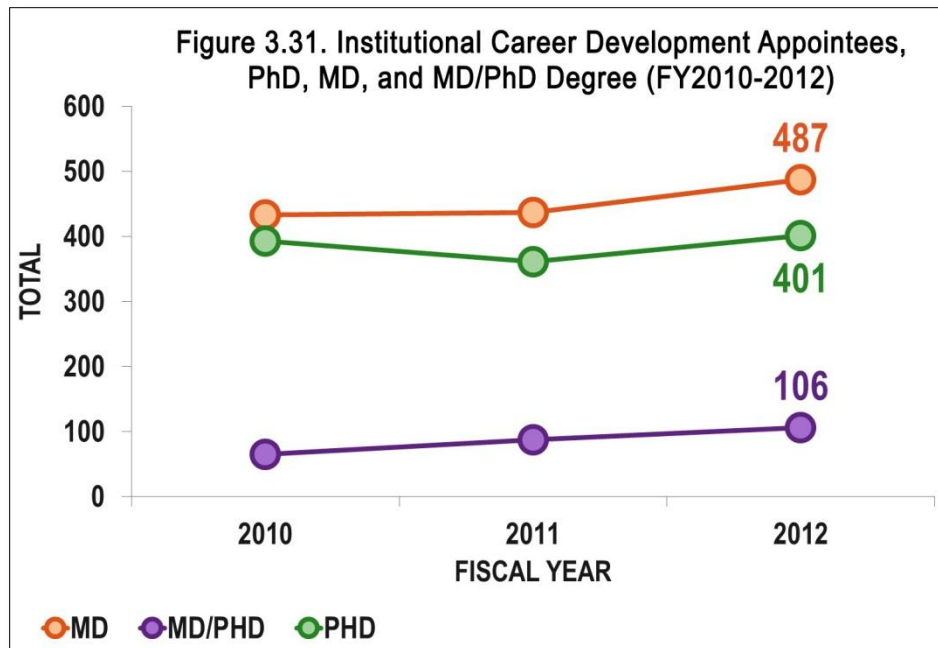
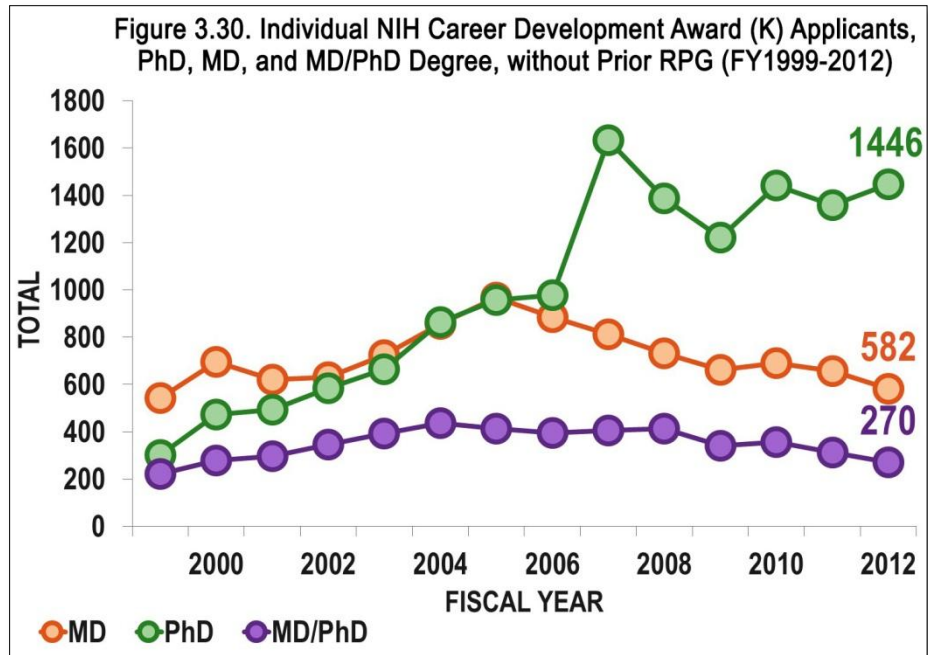
Source: IMPACII

- MD and MD/PhD applicants to LRP and K award programs have declined significantly over the past 5 years, despite stable award rates. Specifically, MD applicants for LRPs declined 36 percent (from 557 in 2008 to 359 in 2012); among MD/PhDs in the same period, applicants declined by 34 percent (from 88 to 58). PhD applicants declined by 45 percent (718 in 2008 to 391 in 2013) (Figure 3.29).

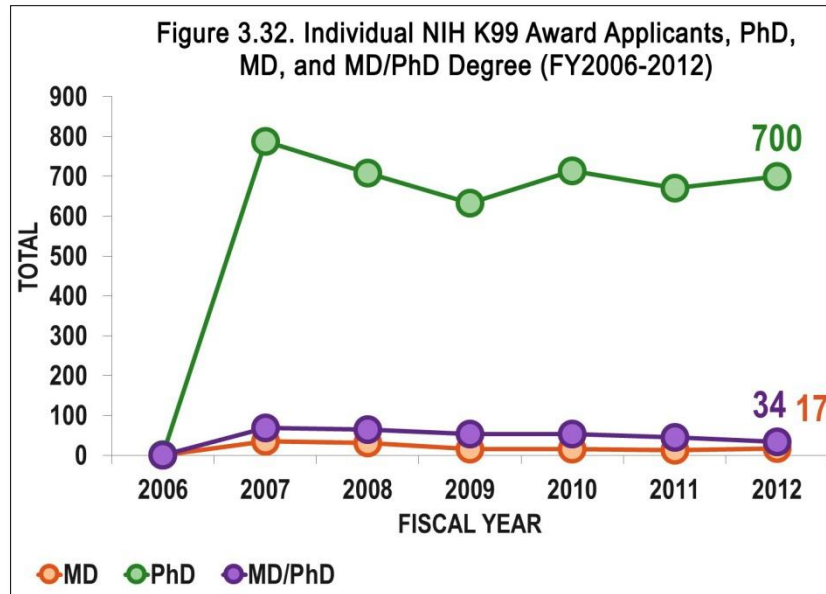
³⁷ The 1980-1989 appointees were chosen in order to have a cohort of individuals who have had time to complete all levels of subsequent training. Since MSTP T32 appointments typically begin in year 1 of an MD/PhD program and completion of the program was 7-8 years on average at that time, this cohort would have graduated in 1987 to 1997.



- For the individual K award programs, MD applicants declined 21 percent (from 733 in 2008 to 582 in 2012); MD/PhD applicants declined 35 percent (from 413 in 2008 to 270 in 2012) (Figure 3.30). During approximately the same period, however, PhD applicants increased, primarily because of the launch of the K99/R00 program (see below). At the same time, appointments of individuals with MDs and MD/PhDs to K12 and KL2 institutional career development awards were also increasing, due in part to the introduction of Clinical and Translational Science Awards (CTSAs) and their associated institutional career development programs. By 2012, appointments to NIH institutional career development awards had grown to include 487 individuals with MDs and 106 holding MD/PhDs, as seen in Figure 3.31 below.



- Introduction of the K99/R00 program in 2007 has increased K applications from PhDs by 48 percent (979 K applications from PhDs in 2006 vs. 1,446 in 2012). Very few of the applicants and awardees are physicians: In 2012, 93 percent of all K99/R00 applicants were PhDs, and 87 percent of the awardees (189/207) were PhDs, as seen in Figure 3.32.



- About 50 percent of LRP recipients (from 2003-2008) have applied for RPGs, and nearly 50 percent have been successful, as seen in Table 3.2, although the numbers are significantly lower for RO1s.

Table 3.2. Total Number of Individuals and Percentage of L awardees (FY 2003-2008) that Applied, were Awarded Subsequent RPG, Subsequent R01

	L awardees (2003-2008)	L awardees that applied RPG	Percentage L awardees that applied RPG	L awardees that were awarded RPG	Percentage L awardees that were awarded RPG	Award rate of L awardees applying RPG
Total	5303	2637	49.70%	1240	23.40%	47.00%
Female	2549	1309	51.40%	579	22.70%	44.20%
Male	2373	1319	55.60%	660	27.80%	50.00%
MD	1941	952	49.00%	411	21.20%	43.20%
PhD	1895	1293	68.20%	640	33.80%	49.50%
MD/PhD	439	301	68.60%	155	35.30%	51.50%
	L awardees (2003-2008)	L awardees that applied R01	Percentage L awardees that applied R01	L awardees that were awarded R01	Percentage L awardees that were awarded R01	Award rate of L awardees applying R01
Total	5303	1917	36.10%	797	15.00%	41.60%
Female	2549	905	35.50%	342	13.40%	37.80%
Male	2373	1010	42.60%	455	19.20%	45.00%
MD	1941	691	35.60%	275	14.20%	39.80%
PhD	1895	917	48.40%	393	20.70%	42.90%
MD/PhD	439	254	57.90%	114	26.00%	44.90%

Source: IMPACII

- More than 80 percent of K program recipients (1999 through 2008) have applied for RPGs. Of those who applied, more than 60 percent have been successful, for an overall K to RPG rate of just 54 percent (Table 3.3).

Table 3.3. Total Number of Individuals and Percentage of K awardees (FY 1999-2008) that Applied, were Awarded Subsequent RPG, Subsequent R01

	K awardees (1999-2008)	K awardees that applied RPG	Percentage K awardees that applied RPG	K awardees that were awarded RPG	Percentage K awardees that were awarded RPG	Award rate of K awardees applying RPG
Total	8229	6967	84.70%	4410	53.60%	63.30%
Female	3408	2851	83.70%	1702	49.90%	59.70%
Male	4760	4109	86.30%	2707	56.90%	65.90%
MD	3240	2654	81.90%	1630	50.30%	61.40%
PhD	2978	2636	88.50%	1652	55.50%	62.70%
MD/PhD	1688	1468	87.00%	1021	60.50%	69.60%
	K awardees (1999-2008)	K awardees that applied R01	percentage K awardees that applied R01	K awardees that were awarded R01	percentage K awardees that were awarded R01	award rate of K awardees applying R01
Total	8229	6226	75.70%	3419	41.50%	54.90%
Female	3408	2496	73.20%	1245	36.50%	49.90%
Male	4760	3723	78.20%	2173	45.70%	58.40%
MD	3240	2355	72.70%	1270	39.20%	53.90%
PhD	2978	2370	79.60%	1265	42.50%	53.40%
MD/PhD	1688	1341	79.40%	823	48.80%	61.40%

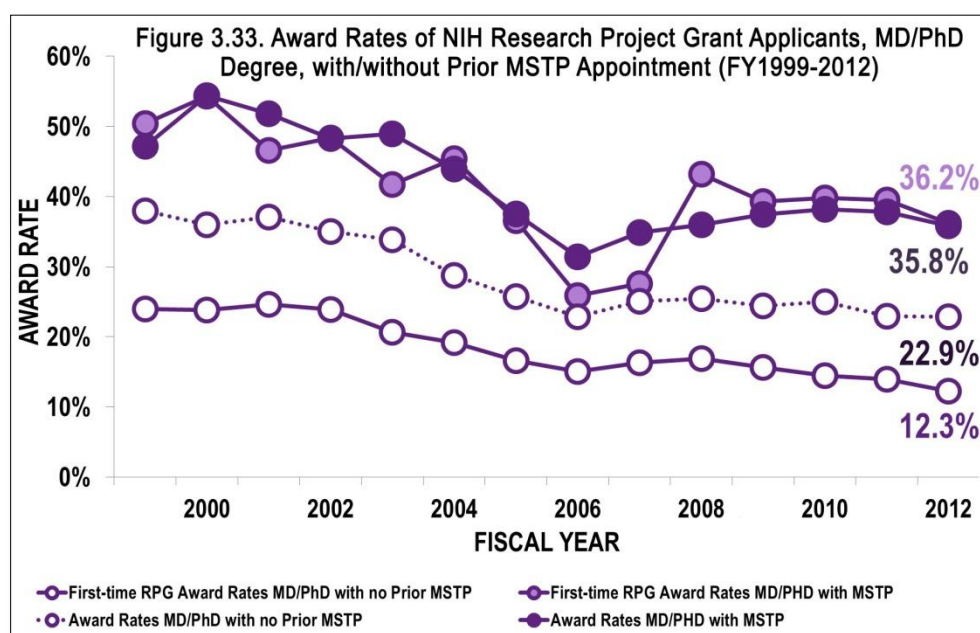
Source: IMPACII

- The award rates for first-time RPG applicants with a prior LRP or K award are much higher than for those without: For MDs: 44.1 percent vs 9.2 percent; for MD/PhDs: 60.0 percent vs 10.1 percent; and for PhDs: 66.3 percent vs 10.9 percent.
- Although more successful in their award rates, physician-scientists with LRP and/or K awards comprised only a small part of the First Time Applicant pool. In 2012, only 14.8 percent of MDs and 13.4 percent of MD/PhDs had a prior LRP or K award.
- Most physician-scientists who were appointed to NIH funded Medical Scientist Training Programs (MSTP) slots in the 1980s have applied for and received RPG and/or RO1 awards. Nearly 80 percent of a cohort of MD/PhDs with initial MSTP appointments in 1980-1989 have applied for RPGs, and approximately 78 percent have been successful (Table 3.4). This cohort was chosen to allow for MSTP appointees (often in the first years of their medical education) to complete education (up to 8 years) and subsequent residency and postdoctoral training.

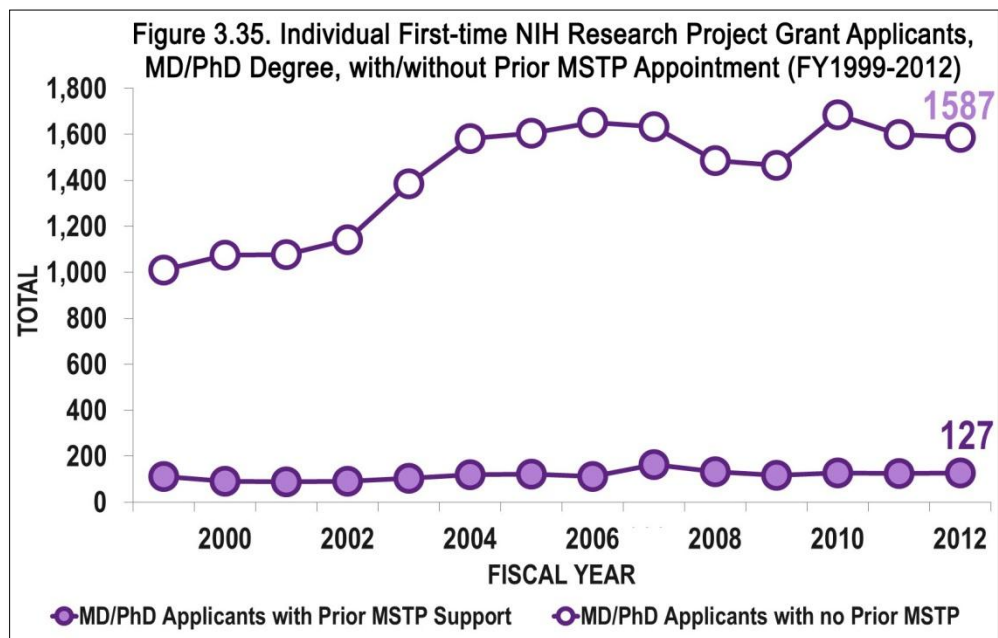
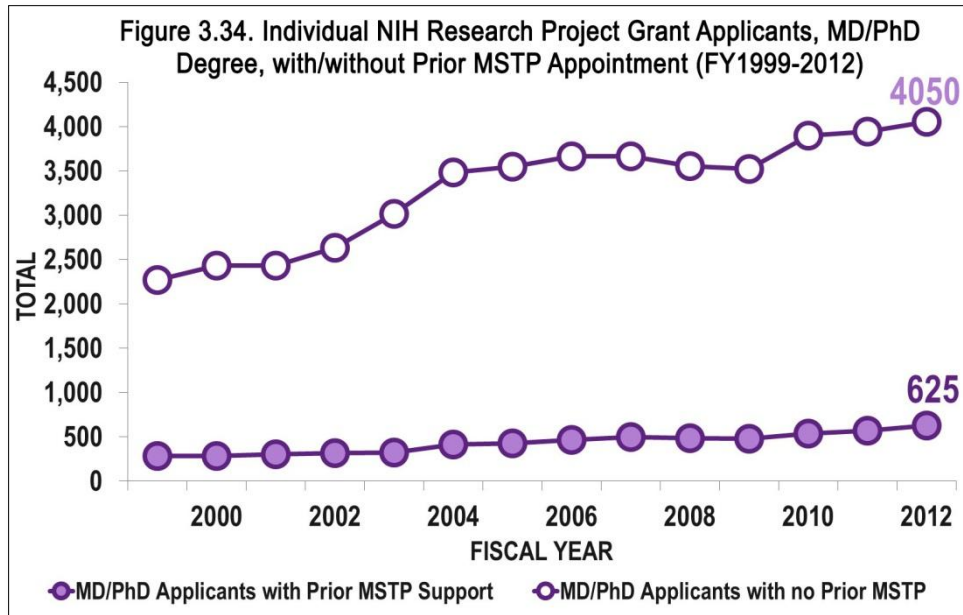
Table 3.4. RPG Applications and Awards Among MSTP Appointees, 1980-1989

	MSTP appointees who completed MD/PhD (1980-1989)	MSTP appointees that applied RPG	Percentage MSTP appointees that applied RPG	MSTP appointees that were awarded RPG	Percentage MSTP appointees that were awarded RPG	Award rate of MSTP appointees applying RPG
MD/PhD	1320	1052	79.70%	828	62.73%	78.71%
	MSTP appointees who completed MD/PhD (1980-1989)	MSTP appointees that applied R01	Percentage MSTP appointees that applied R01	MSTP appointees that were awarded R01	Percentage MSTP appointees that were awarded R01	Award rate of MSTP appointees applying R01
MD/PhD	1320	970	73.48%	724	54.85%	74.64%

- The award rates for first-time RPG MD/PhD applicants with a prior MSTP appointment are much higher than for those without: in 2012, 36.2 percent for those with MSTP appointments and 12.3 percent for those without, as illustrated in Figure 3.33.



- MD/PhDs with past MSTP support comprise only a small part of the total pool of RPG applicants with MD/PhDs (for all applicants as well as first time). In 2012, only 13.4 percent of MD/PhD applicants had prior MSTP support (Figure 3.34) and 7.4 percent of first-time applicants with MD/PhDs had prior MSTP support (Figure 3.35).



Current Status of the Physician-Scientist Workforce

Based on our analysis of the current workforce, we estimate that there are currently 14,000 physician-scientists in the United States, of whom ~8,000 have Research Project Grants from the NIH. The total number of physician-scientists with a medical degree is now slowly declining. If the average career of physician-scientists is 30 years in duration, we estimate that about 1,000 individuals will need to enter the pipeline each year to maintain the steady state, assuming that 50 percent of people who enter the pipeline will not succeed. About 500 of these individuals currently come from among those who hold both an MD and PhD (earned in a combined program or sequentially in the United States or abroad). The rest must come from the pool of MDs who become interested in research during their clinical training. The average age of physician-scientists is steadily increasing due to factors that include longer training times, higher grant success rates for established investigators, and postponement of retirement.

Challenges Facing the Physician-Scientist Workforce

A number of challenges confront the physician who elects to pursue a research career. Increases in the cost of obtaining medical education can burden students with high amounts of debt, especially those who were not enrolled in a combined MD/PhD program. The training required to obtain competency in clinical and scientific research continues to increase, resulting in a marked prolongation of the training process. The transition between finishing a clinical or post-doctoral fellowship and initiating an independent research position is a very vulnerable period in the career path of all physician investigators. Financial pressures have mounted with the decrease in NIH funding, and physician-scientists are increasingly being asked to support a higher percentage of their salaries by seeing patients.

PSW-WG data clearly indicate that young physician-scientists are at the greatest risk of leaving the career path. There has been a steady decline in the size of the applicant pool for early stage NIH grants in the past five years, as shown above.

Women appear to be particularly challenged because they are often having their children at the same time that they are starting their laboratory. Finally, more cumbersome requirements have been added to the process of maintaining board certification for clinical practice, which may accelerate the exit of physician-scientists from the bedside.

Key factors that put pressure on early career physician-scientists include:

- Impact of research funding
- Length and structure of training
- Debt
- Work-life balance/ integration including leave policies, family life and child care
- Influence of Mentoring
- Tension between clinical and research responsibilities
- Maintenance of board certification

Impact of Research Funding

Qualitative research undertaken by and on behalf of the PSW-WG indicated that the uncertainty of funding is by far the biggest concern of young physician-scientist faculty; its importance cannot be overestimated. K awards, other than the K99/R00, typically provide inadequate support at the time needed to launch a career as an independent investigator. Therefore, new investigators may spend time writing grant applications and seeing patients, rather than generating preliminary data for an R01 application. Furthermore, MD applicants for R01 grants may be at a disadvantage during the grant review process because study section reviewers do not understand the career paths of physician-scientists, and may interpret fewer publications (compared to PhD scientists) as a lack of productivity, rather than time spent in training and clinical responsibilities.

Laboratory-based physician-scientists have all the challenges of other investigators, but additional factors contribute to the decrease in numbers and proportions of MD investigators who successfully transition through this period of their career. The PSW's qualitative research suggests that start-up packages for laboratory-based physician-scientists are often not as large as those for PhDs, potentially due to a much higher percentage of MD investigators staying at their training institution.

Length and Structure of Training

The number of years required to become a physician-scientist is daunting and may be a barrier to recruiting an adequate supply of physician-scientists. The sequence and structure of training is also problematic. For those pursuing dual degree programs that are structured as two years of medical school, then four years of graduate school, followed by two more years of medical school and then residency and fellowship, their research skills often become outdated before they can return to the laboratory. Those with medical degrees who wish to pursue in-depth research training may find their options limited, unless they are at research-intensive institutions.

Integral to these aspects of training is the age factor. The extended education and training in the dual degree MD/PhD track, delay for family leave, and other factors contribute to the increasing age of early-stage investigators and attrition from the physician-scientist track towards other careers.³⁸ The age factor is illustrated by the trend of the average age of first time RPG awards increasing since 1999 for MDs, MD/PhDs, and PhDs.³⁹ With the 2014 release of the NIH Pathway to Independence Award (Parent K99/R00, PA-14-042), NIH encourages applicants to apply before they complete 4 years of post-doctoral experience, thereby moving researchers' timetable to become an independent investigator earlier in their career.⁴⁰ Of note, very few MDs have been applying to the K99/R00 mechanism: In 2012, only 51 MDs and MD/PhDs applied for a K99/R00, compared to 700 PhDs.

³⁸ Gordon, R., (2012) The vanishing physician scientist: a critical review and analysis. *Account Res.* 19(2), 89-113

³⁹ Koniaris, L.G., Cheung, M.C., Garrison, G, Awad, W.M. Jr, Zimmers. T.A., (2010, Apr). Perspective: PhD scientists completing medical school in two years: looking at the Miami PhD-to-MD program alumni twenty years later. *Academic Medicine.* 85(4), 687-91

⁴⁰ NIH Office of Extramural Research (OER), Research training & research career development. (2014). Retrieved, from <http://grants.nih.gov/training/index.htm>

Debt

Debt burdens limit career options for laboratory-based physician-scientists. Eighty-six percent of students graduating from medical school in 2013 carried a student debt burden; the median debt was \$175,000. Resident/fellowship stipends at this same period were in the low-to-middle \$50,000 range.⁴¹

Becoming a physician-scientist prolongs the training period at compensation levels lower than clinical careers; this can be particularly difficult for individuals with substantial debt and/or young families.

Work-Life Balance/Integration

NIH supported research on causal factors and interventions that affect the careers of women in biomedical and behavioral science and engineering. Results from the research described one of the factors as struggling to attain a work-life balance in order to establish a healthy work climate. The work-life issues faced by both male and female professionals included family life, child care, finances (debts and wage compensation), geographic location, and other interests. Among the study population of NIH K08 and K23 trainees, women were less likely to apply for tenure-track positions especially among women with children or planning to have children. The flexibility policies that address work-life balance were reported to vary widely throughout the range of scientists and physicians workplaces. Institutional flexibility policies were reported to be under-recognized and under-used. Challenges to overcoming academic culture which countered these policies contributed to frustrations in workplace satisfaction among both men and women.⁴²

Influence of Mentoring

The impact of an effective mentor-mentee relationship is a well-recognized factor in career success of the mentee. Both men and women linked their career satisfaction with their mentoring experience. Results from the NIH supported research on causal factors and interventions that affect the careers of women in biomedical and behavioral science and engineering described the importance of receiving effective mentoring. Among the study population of NIH K08 and K23 trainees, women described different mentorship of their career development than men. The results showed that in order to achieve effective mentoring, a mentoring network, rather than a single mentor, is important as well as including multiple mentors representing diverse expertise, experience, resources, and background.⁴³

A major difference between physician-scientists and PhD scientists is that the physician-scientists often have multiple individuals who have control over their careers. They have a scientific mentor, a clinical mentor and sometimes also have to answer to the leadership of the health care system. All of these supervisors request different things from the physician-scientists: to focus on their research, to take care of patients, to participate in the education of scientists in the laboratory and classroom, to participate in the education of medical students and fellows in the classroom and clinic, to maintain a clinic and to

⁴¹ Association of American Medical Colleges. (October 2013). Medical student education: Debt, costs, and loan repayment fact card. <https://www.aamc.org/download/152968/data/debtfactcard.pdf>

⁴² NIH causal factors and interventions workshop summary. (2012). Retrieved, from <http://orwh.od.nih.gov/career/pdf/Causal-Factor-Summary.pdf>

⁴³ Ibid.

attend on ward services. Oftentimes, the physician-scientists lack a mentor who can help balance and protect them, especially during the most vulnerable part of their career, at its beginning.

Tension between Research and Clinical Responsibilities

Academic medical centers, where most physician-scientists are employed, are under increasing financial pressures. Their need to increase clinical revenue to maintain current levels of operation can translate into pressures on physician-scientists to see more patients at the expense of protected research time.

At the same time, the current environment does not encourage laboratory-based physician-scientists with clinical training to maintain their clinical skills. In some cases, laboratory-based physician-scientists are pressured to give up all patient care activity because their clinical revenue-generating capacity is exceeded by their practice expenses. For example, malpractice expenses are usually not prorated for amount of clinical activity and can exceed clinical revenue, so laboratory-based physician-scientists can be viewed as “money losers.” Therefore, many abandon (or are pressured to abandon) clinics to maintain their research program.

Finally, many lab-based physician-scientists are housed in clinical departments where some feel increasingly out of place and unsupported. The fraction of MD/PhD program graduates with a primary appointment in a basic science department, never high to begin with, declined to 9 percent for the cohort of individuals who graduated after 1998.⁴⁴ Due to the recent financial pressures facing the clinical departments, emphasis has increasingly been focused on maximizing the efficiency and financial health of the clinical services, rather than on the generation of new knowledge. Physician-scientists often do not get sufficient administrative support as the regulatory demands of conducting both clinical and lab-based science continue to increase.

Maintenance of Board Certification

Specialty and subspecialty board certification and recertification are becoming increasingly time-consuming and demanding, which is impacting the decisions made by junior physicians about their career paths. Such certification is necessary for a professional with clinical activities to maintain hospital privileges and to bill as a specialist. Although a number of boards have designated research tracks, some of the boards impose requirements that may discourage trainees from a research career. Maintenance of certification processes developed by some boards appears to be discouraging physician-scientists from maintaining their clinical privileges.

A large percentage of physician-scientists voluntarily restrict the scope of their practice to narrow “super subspecialties” and are often the most clinically knowledgeable physicians in these areas because of their experience in assessing cohorts of patients with rare disorders. Thus, they can have a profound effect on the quality of care delivered by large numbers of more general subspecialty physicians who seek their advice and refer patients for consultation.

Finally, policies that discourage physician-scientists from maintaining certification also diminish the value of the physician-scientists to the biomedical enterprise, since a physician-scientist becomes a

⁴⁴ Brass et al, *ibid*.

depreciating asset when she or he stops being actively engaged in medical practice: clinical acumen begins to decay with lack of use.

There is a need for certifying boards to collaborate with the physician-scientist community, federal agencies and payers to find more targeted and efficient ways to assess the very focused practice of such physician-scientists. The PSW-WG applauds the plans of the American Board of Medical Specialties (ABMS) and its member boards to consider the special issues of physician-scientists through a special committee review planned later in the year.

Chapter 4

Nurse-Scientists

Nurse-scientists occupy a unique and fundamental position in the health research enterprise. Nursing science provides the evidence base to support the practice of the largest healthcare profession, as well as to improve wellness and quality of life for all individuals. For example, Dr. Margaret Grey developed approaches to teaching adolescents the skills needed to successfully manage their diabetes; Dr. Loretta Sweet Jemmott pioneered ways to help young minority men and women reduce their risk for acquiring HIV; and Drs. Jon Levine and Christine Miaskowski increased medicine's understanding of why men and women respond differently to pain medication. Given the rise in the incidence of long-term chronic illness, it is critically important that improving the quality of life for those with chronic illness remains a primary focus of nursing research. Nurse-scientists provide evidence-based strategies for maintaining wellness and preventing illness from occurring in the first place. The patient-centered, interdisciplinary field of nursing science plays a vital role in achieving this vision:

- Nurse-scientists have improved clinical practice and patient outcomes through the development of interventions that have been implemented across the U.S. These interventions have included early child care programs, programs to reduce risk behaviors in adolescents, self-management strategies for chronic illnesses in youth and adults, and programs incorporating new technologies to enhance quality of life.
- Health care policy and legislation have been influenced by nurses who serve as elected officials or staff in state and federal legislatures and by nurses who lead governmental agencies such as the Health Resources and Services Administration and the Centers for Medicare and Medicaid Services. Nursing science has informed legislation and policy through studies that have tested transitional care models, and others that have documented the impact of nurse education and staffing levels on patient outcomes.

Research training and career development are critical elements to cultivate the next generation of nurse-scientists. To ensure continued advancements in science and improvements in health, it is essential that the scientific workforce of the future be innovative, multidisciplinary, and diverse. Nurse-scientist training programs are designed to achieve this vision. Improving research capacity in nursing science has been recognized as an essential component for improving health care and health systems. In 2011, for example, the Institute of Medicine (IOM) released *The Future of Nursing: Leading Change, Advancing Health*, highlighting the importance of nursing science and capacity building for improving the health of the Nation.

Training of Nurse-Scientists

Nurse-scientists usually begin their education with a Bachelor of Science in Nursing (BSN) degree; most enter clinical practice at that point. The nursing profession traditionally has viewed clinical experience as a prerequisite to graduate education and new graduates were encouraged to practice clinically by faculty

and peers between degrees rather than continuing straight on to obtain a PhD.⁴⁵ This career path has resulted in the norm of nurses returning for a master's degree in their mid-thirties to become an advanced practice nurse (e.g., nurse practitioner or clinical nurse specialist) or administrator, then returning to the work force for another decade, and finally returning to graduate school to obtain a PhD in their late thirties or even older.⁴⁶ Nurse-scientists complete their doctoral degrees, on average, at the age of 47, which limits the number of years they have to build a scientific program and contribute to the scientific base of nursing practice.⁴⁷

Nurses with advanced degrees such as nurse practitioners, nurse anesthetists, and nurse executives command significantly higher salaries than nurse-scientist faculty at research institutions. This is an important disincentive to return to school to obtain a PhD. Although academics in all disciplines are rarely compensated at the same level as their peers in practice or industry, the disparity for nurses is one of the largest. In fact, clinical nurses working in hospitals or ambulatory care, nurse practitioners, nurse anesthetists and others have average salaries that are 30 percent higher than those of assistant professors of nursing.⁴⁸

Trends in Nurse-Scientist Training

Despite the barriers cited above, nurse-scientist training has been on the upswing:

- In 2012, 131 schools of nursing (19 percent of 677 nursing programs) offered research-focused PhD programs.⁴⁹
- Enrollment in nursing doctoral, research-focused education increased 28.6 percent from 2008-2012.⁵⁰
- Graduations from nursing, research-focused doctoral programs increased 11.7 percent from 2008-2012.⁵¹

⁴⁵ Dracup, K, Greiner, D.S., Haas, S.A., Kidd, P., Liegler, R., MacIntyre, R., et al.(2009). Faculty shortages in baccalaureate and graduate nursing programs: Scope of the problem and strategies for expanding the supply .Retrieved from: <http://www.aacn.nche.edu/Publications/WhitePapers/FacultyShortages.htm>
As cited in: IOM (Institute of Medicine). 2011. *The Future of Nursing: Leading Change, Advancing Health*. Washington, DC: The National Academies Press p.I-36-37

⁴⁶ IOM, 2011.

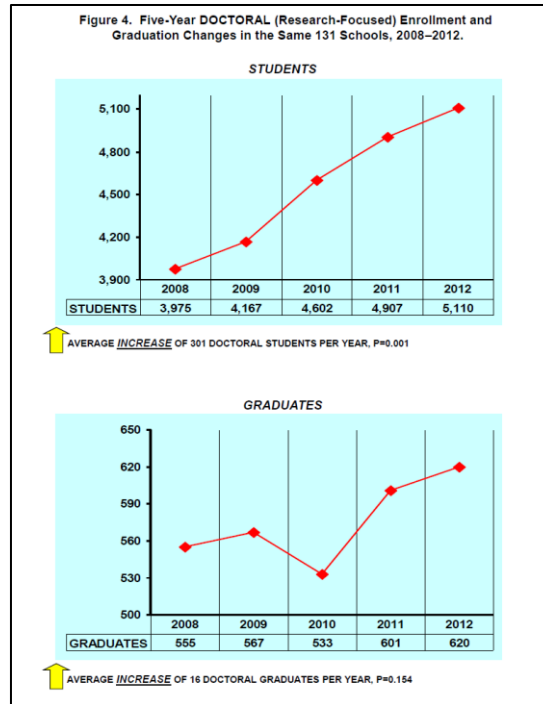
⁴⁷ Dracup, 2009.

⁴⁸ IOM. 2011.

⁴⁹ Fang, Li, Bednash, AACN, 2013.

⁵⁰ Ibid.

⁵¹ Ibid.



Schools of nursing offer both full- and part-time doctoral programs in order to attract and accommodate the best talent. In Fall 2012, 45 percent of 5,110 individuals enrolled in research-focused doctoral programs were enrolled part-time.⁵² However, part-time programs take longer to complete, which contributes to the older age of research faculty.

Table 4.1. Enrollment Changes in Nursing Schools, 2011-2012

Enrollment Changes in Same Schools Reporting in Both 2011 and 2012 by Type of Degree (From Tables 11&12, AACN, 2013)					
DEGREE	NUMBER OF SCHOOLS	2011 STUDENTS	2012 STUDENTS	INCREASE/DECREASE	PERCENT CHANGE
RESEARCH-FOCUSED Doctorate	131				
Full-time		2,639	2,787	148	5.6
Part-time		2,268	2,323	55	2.4
TOTAL		4,907	5,110	203	4.1

Influence of Doctor of Nursing Practice (DNP) Degree

The development of a professional doctorate may also affect the numbers of nurses pursuing a PhD. The Doctor of Nursing Practice (DNP) was introduced in 2004 by the American Association of Colleges of Nursing (AACN) with a recommendation by its members to adopt the DNP degree for all advanced practice nurses by 2015. In 2012, 217 schools reported offering the DNP degree.

⁵² Fang, Li, Bednash, AACN, 2013.

- The degree is designed as the terminal degree for advanced nursing practice with a focus on quality improvement and research translation.
- Whether or not DNP programs will attract applicants that would have been interested in a PhD is unknown and what effect it will have on future PhD applications is also unknown. However, it is important to note that the program is focused on preparing its graduates “to fully implement the science developed by nurse researchers prepared in PhD, DNSc, and other research-focused nursing doctorates.”⁵³ Its graduates are not expected to contribute scientific discoveries or to lead interdisciplinary teams of scientists. Thus, “the DNP will not meet the need for more nurse-scientists and it may contribute to their shortage.”⁵⁴ In 2012 there were over 11,000 students enrolled in DNP programs, a 27 percent increase from 2011.⁵⁵

NIH Support of Nurse-Scientist Training

At the NIH, the National Institute of Nursing Research (NINR) supports training of nurse-scientists through intramural opportunities such as the Graduate Partnership Program and through extramural opportunities that include both institutional and individual training awards. For the GPP program, 16 nursing PhD students have participated to date. From an extramural perspective, NINR supports the T32 institutional training grants; F31, F32, and F33 individual fellowship awards; and the K01, K23, K24, and K99/R00 awards for early career investigators. In the past NINR also supported the K08 mechanism.

In response to the need for new nurse researchers and faculty, NINR currently spends approximately 8 percent of its appropriated funds on the training of nurse-scientists. As a percent of budget, this is more than most NIH Institutes and Centers (ICs) spend on pre- and post-doctoral training.

The Nurse-Scientist Workforce

Size and Composition of the Current Nursing Science Workforce

In 2008, an estimated 28,369 nurses (<1 percent of all RNs in the U.S.) had a doctoral degree in nursing or a related field. This represents an **increase of 64.4 percent since 2000**. Of nurses with a doctorate degree, over 22 percent had a primary focus on research.⁵⁶

A study conducted by the AACN detailed the employment commitment for doctoral program graduates from 2008-2012. Of note, 620 nurses graduated with a “research-focused doctoral degree.” At the time of graduation, they had employment commitments to:

- Faculty position – n=302 (48.7 percent)
- Federal or state government agency – n=10 (1.6 percent)
- Post-doctoral fellowship- n=36 (5.8 percent)

⁵³ American Association of Colleges of Nursing (2010). *The research-focused doctoral program in nursing pathways to excellence*.

⁵⁴ IOM (Institute of Medicine). (2011). *The future of nursing: Leading change, advancing health*. Washington, DC: The National Academies Press.

⁵⁵ Fang, D. Li, Y., Bednash, G.D. (2013). *2012-13 enrollment and graduations in baccalaureate and graduate programs in nursing*. American Association of Colleges of Nursing.

⁵⁶ U.S. Department of Health and Human Services, Health Resources and Services Administration (2010). *The registered nurse population: Findings from the 2008 national sample survey of registered nurses*.

- Hospital/Ambulatory position – n=76 (12.3 percent)
- Other positions – 36 (5.8 percent)
- No employment commitment – 160 (25.8 percent)⁵⁷

Some schools of nursing offer options for doctoral education. For example, seven offer dual degree options where graduates obtain both a research-focused doctorate and an MBA. Another option offered by 79 schools is targeted to individuals who have a Baccalaureate degree in another field. These students complete their RN to PhD with a goal of “fast tracking” completion of the research-focused degree.⁵⁸

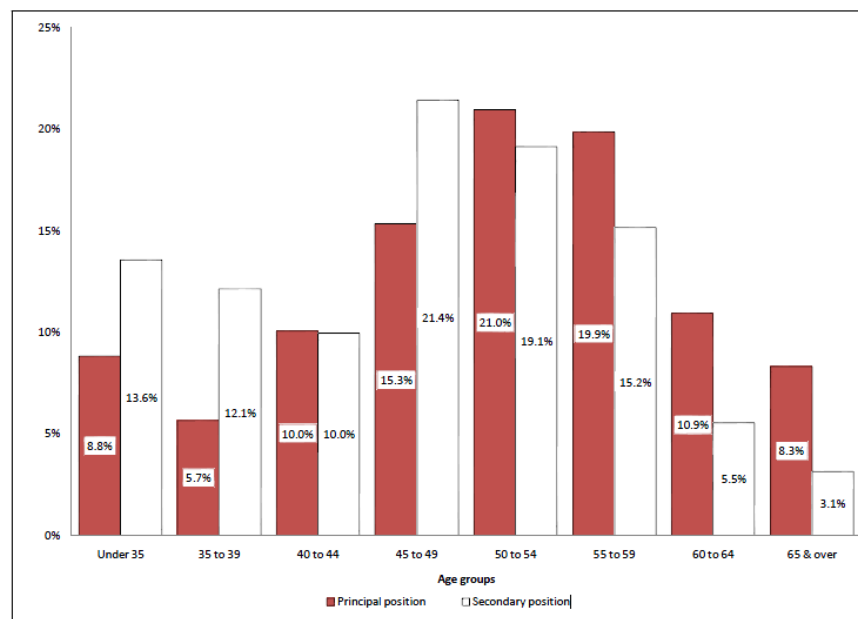
Gender

Nursing is a female-dominated profession with men representing only 6.6 percent of the U.S. nursing workforce. In 2012, 7.9 percent of students in research-focused nursing doctoral programs were men.⁵⁹

Age

The nursing science research workforce is aging. Most nurse-scientists are research faculty in nursing schools. In 2008, 60 percent of faculty in schools of nursing were 50 years of age or older.⁶⁰

FIGURE 4.2. AGE DISTRIBUTION OF REGISTERED NURSES WHO WORK AS FACULTY⁶¹



Source: 2008 National Sample Survey of Registered Nurses

⁵⁷ Fang, Li, Bednash, 2013. Ibid.

⁵⁸ Ibid.

⁵⁹ Ibid.

⁶⁰ HRSA, 2010.

⁶¹ Ibid.

Qualitative Research Findings Related to Nurse-Scientists

Qualitative research conducted on behalf of the PSW-WG (see [Appendix V](#)) included interviews with three nurse-scientists with K23 awards. These individuals had each worked as a clinical nurse or clinical nurse specialist before going back to school to earn a PhD. Thus, they were in their 40s or 50s when they received their K awards.

These respondents asserted that a 3-year K award is too short of a time frame to get a research project up and running, collect and analyze data, and then write and get manuscripts accepted in journals so that they can write a competitive application for an R01. These nurse-scientists also said they needed more support through the K award for lab equipment, lab space, and lab assistants.

The respondents indicated that they needed to carry a large teaching load to make up for salary deficits from grant funding. This can make it difficult to keep their research projects moving forward. However, as one stated: "Nurses who want a research career are tied to academia. Some large hospitals are doing some nursing research, but not as much."

All liked the idea of team science. They felt they were in a collegial atmosphere where team science works well.

Work/life balance was definitely top of mind for those with children currently at home. However, they also noted that they have support from their colleagues and are able to resolve any work/life balance issues that may arise.

In January 2014 the National Institute of Nursing Research (NINR) conducted an open-ended survey of a purposive sample of nine deans of nursing schools with research-focused training programs. The purpose of the survey was to gather information regarding the experiences of schools of nursing in training successful nurse-scientists. The key findings were:

- NINR funding allowed schools of nursing to attract more competitive trainees and recruit junior research faculty with high potential for developing funded programs of research.
- Schools equated trainee success with peer-reviewed publications, subsequent research funding, and post-training research positions.
- Research experiences for trainees ranged from required "research residencies" to working on mentor's studies.
- Interdisciplinary research and collaborations are encouraged at all schools.
- Salaries for registered nurses are significantly higher than training stipends. Since NRSA and T32 grants have restrictions on outside work while providing low stipends, many pre-doctoral and post-doctoral students opt not to apply for these training grants.

Nurse-Scientists as Participants in the NIH-funded Workforce

Identifying nurse-scientists who receive NIH support is difficult. Nurse-scientists have research degrees (generally a PhD) and their nursing degree often does not appear on the NIH application.

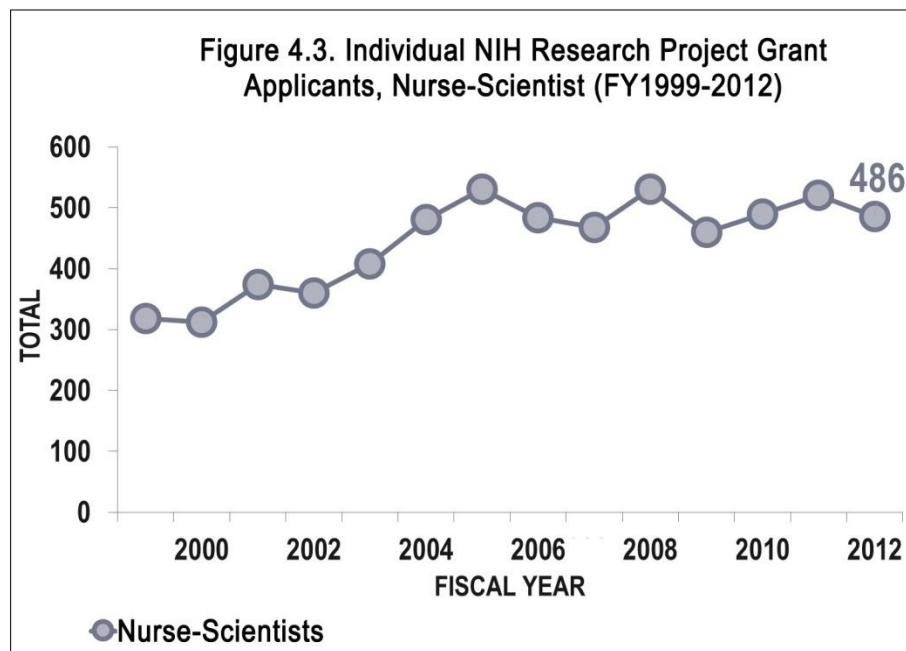
To gather data on the trends for nurse-scientists as participants in the NIH-funded workforce, the following search strategy was employed in the NIH data system: Principal Investigators (PIs) were categorized as nurse-scientists if they listed any nursing degree or license in the following list: RN, RNP,

BSN, MSN, ANP, PNP, ARNP, FNP, CRNA, DSN, CNM, DNSc, DNS, DNP, FAAN, DRNP, CAN, APRN, CNRN.

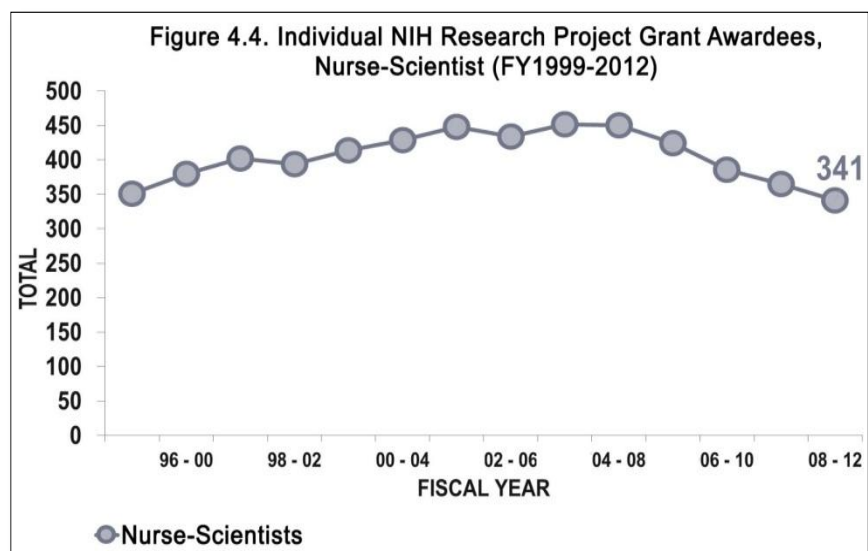
This search strategy may substantially underestimate the number of nurse-scientists. To obtain more accurate numbers of nurse-scientists would require analysis of the “field of study” field and review of biosketches. Thus the numbers in the charts should be viewed as rough estimates of trends.

NIH RPG Award Rates

Between 1999 and 2012, there was a 53 percent increase in the number of nurse-scientist applicants for NIH research project grants (RPG), as seen in Figure 4.3. Most of this increase happened between 1999 and 2005. Between 2005 and 2012, the number of applicants has been relatively flat.



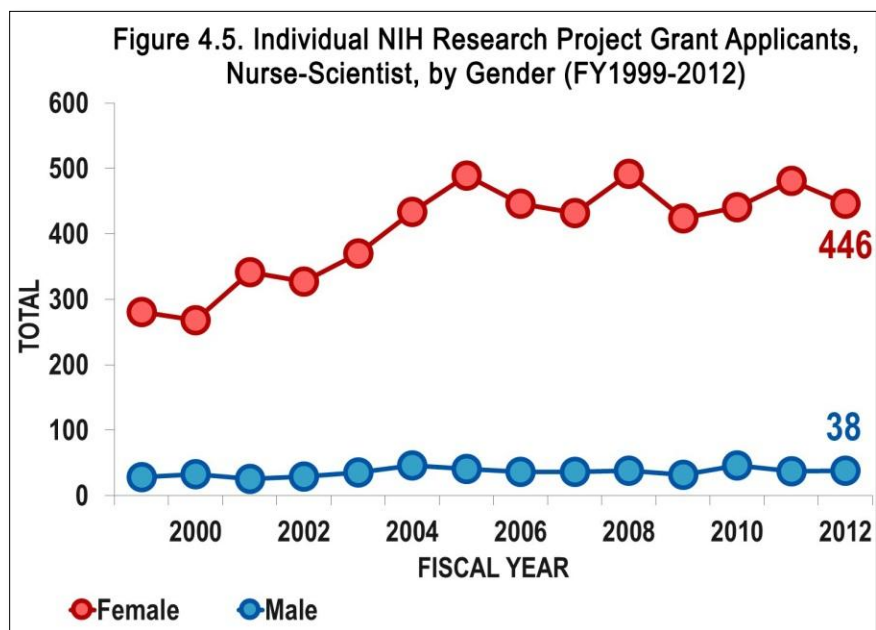
The number of nurse-scientist awardees increased modestly until recent budget constraints (Figure 4.4).



Data were aggregated over 5 year windows to reduce double counting of individuals who apply multiple times or were awarded multiple grants during that window.

Gender

Among nurse-scientists applying for and receiving RPGs from the NIH, women outnumbered men by approximately nine to one (see Figure 4.5); during this period, men and women had similar individual RPG award rates.



Effects of Early Career NIH Programs on Nurse-Scientists

Between 1992 and 2012, NINR supported 388 post-doctoral appointees via the T32 mechanism (see Table 4.2). Of these, 219 could be identified in the IMPACII database using the previously described

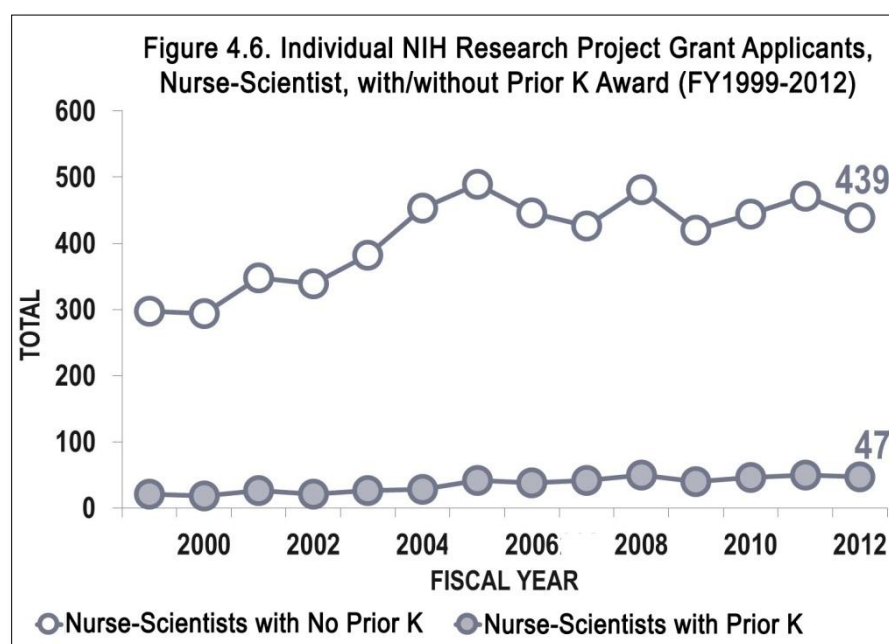
search strategy for the years 1999 to 2008. Of the T32 trainees identified, 91 (41.6 percent) subsequently applied for a research project grant (RPG). Of those who applied, 31.87 percent were awarded grants. When looking specifically at R01 RPGs, 47 of the T32 appointees applied and nine (19.2 percent) were awarded grants.

Table 4.2. RPG Applications and Awards Among T32 Postdoctoral Appointees, 1999-2008

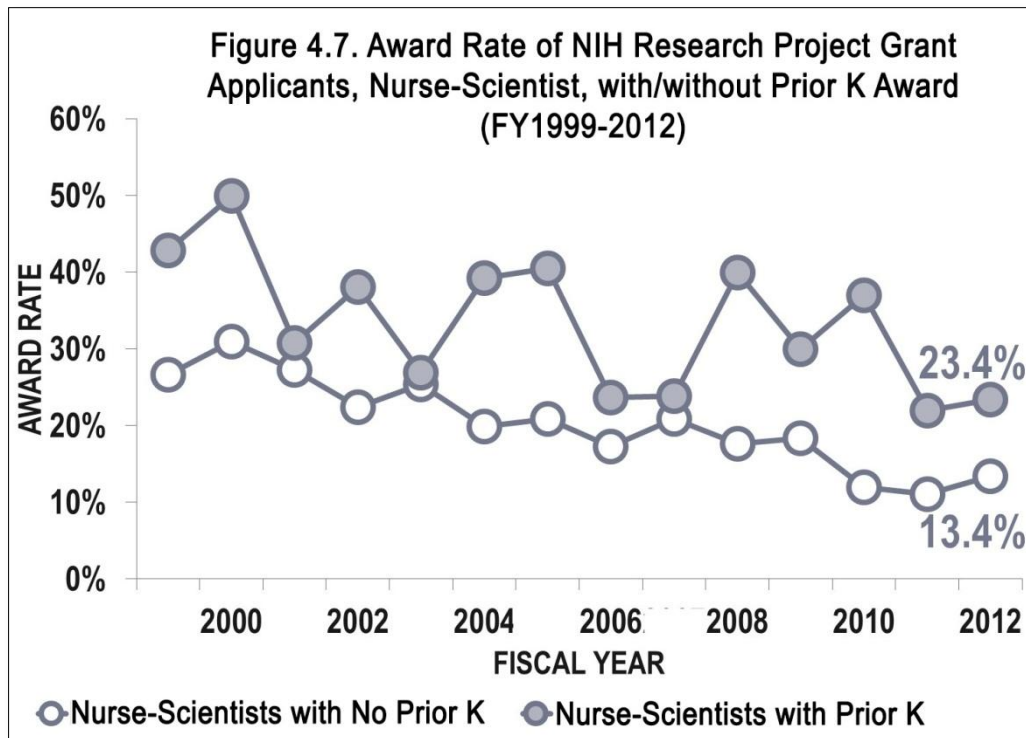
	T32 appointees (1999-2008)	T32 appointees that applied RPG	Percentage T32 appointees that applied RPG	T32 appointees that were awarded RPG	Percentage T32 appointees that were awarded RPG	Award rate of T32 appointees applying RPG
Nurse Scientist	219	91	41.60%	29	13.24%	31.87%
	T32 appointees (1999-2008)	T32 appointees that applied R01	Percentage T32 appointees that applied R01	T32 appointees that were awarded R01	Percentage T32 appointees that were awarded R01	Award rate of T32 appointees applying R01
Nurse Scientist	219	47	21.46%	9	4.11%	19.15%

Source: IMPACII

Between 1999-2012, the number of nurse-scientists who had received K awards and then applied for RPGs remained relatively flat. In 2012, of the 486 nurse-scientists who applied for RPG funding, 47 (approximately 10 percent) had a prior K award (Figure 4.6).



Between 1999 and 2012, nurse-scientist RPG applicants who had a prior K award had higher award rates than did those without a prior K award, as seen in Figure 4.7. For example in 2012, 23.4 percent of nurse-scientists who had a prior K award received a RPG compared with 13.4 percent of those who did not have a prior K award.



Summary of Challenges Facing the Nurse-Scientist Workforce

All clinical scientists face similar challenges although the extent of the challenges on a spectrum varies from discipline to discipline. Nurse-scientists especially are faced with:

- Balancing clinical and research responsibilities,
- The fact that ‘team science’ and interdisciplinary work is essential for addressing the complex problems facing clinician-scientists, but it also takes more time and probably additional training to work together,
- The aging nursing workforce and need to speed up the pipeline in nursing education to meet increasing demands for complex nursing care and research,
- The impact of gender on ability to devote time to research skills (i.e., the majority of nurses and an increasing proportion of MDs and veterinarians are women who still assume the bulk of child rearing responsibilities).

As the need for nursing education and research and for nurses to engage with inter-professional research teams has grown, the numbers of nurses with a PhD in nursing or a related field have not kept pace. The main reasons for this lag are:

- An inadequate pool of nurses with PhDs to draw upon,
- Faculty salaries and benefits that are not comparable to those of nurses with advanced degrees working in clinical settings, and

- A culture that promotes obtaining clinical experience prior to continuing graduate education.⁶²

Specific Recommendations Related to the Nurse-Scientist Workforce

Most of the recommendations that impact nurse-scientists may be found in [Chapter 7](#). The following recommendations are unique to nurse-scientists and responsive to the challenges identified above.

1. Increase NIH support for nurse-scientists to engage in team science, particularly at institutions where there is an existing cadre of nursing researchers to serve as mentors.
2. NIH should encourage more people to take advantage of currently offered programs that provide research training for nurses earlier in their careers, including programs that admit students into doctoral-level training directly following their undergraduate degrees.

⁶² IOM, 2011.

Chapter 5

Veterinarian-Scientists

Veterinarians contribute to biomedical research through the application of their specialized training in animal biology and medicine to the modeling of human physiology and disease. The veterinary curriculum is analogous to medical school training but provides comparative overviews of normal anatomy/physiology and abnormal disease states, providing an excellent basis for biomedical disease inquiry. Veterinary contribution in clinical research can be extremely helpful in determining strengths and weaknesses in animal disease models, and thus inclusion of veterinarians on translational research teams can provide an invaluable dimension to pre-clinical studies.

Veterinarian-scientists have made important contributions to research in human diseases. For example, in 1991, Peter C. Doherty received the Nobel Prize in Physiology or Medicine for discoveries concerning the specificity of the cell-mediated immune response in virus infections. James Thomson, a veterinary pathologist, derived the first human embryonic stem cell line in 1998. Veterinarians William Karesh and Jonna Mazet lead large, multi-disciplinary studies at the human-animal interface and wildlife health have been instrumental in elucidating the origins and potential 'hotspots' for emergence of MERS coronavirus, Avian Influenza, Ebola, and other emerging diseases. Work by veterinarian James Fox has advanced the field of infectious disease of the GI tract, including performing seminal studies on *Campylobacter* and *Helicobacter* pathophysiology.

The majority of diseases that occur in humans also occur spontaneously in animals.⁶³ Approximately 75 percent of recently emerging infectious diseases affecting humans are diseases of animal origin; approximately 60 percent of all human pathogens are zoonotic.⁶⁴ Thus, a physician-scientist workforce that includes practitioners with broad understanding of animal anatomy, physiology, pharmacology, and diseases is paramount for the advancement of many human biomedical health initiatives. Recognition of this is evident in the worldwide *One Health* initiative that is dedicated to improving the health of all species — human and animal — through the integration of human health care and veterinary medicine.

Training in Veterinary Medicine

There are 28 veterinary medical colleges, nine departments of veterinary science, and eight departments of comparative medicine in the United States, according to the Association of American Veterinary Medical Colleges (AAVMC). Two additional schools are expected to open in 2014.

The American College of Veterinary Medicine Council on Education (AVMA COE) outlines an accreditation process to assure high standards of achievement for veterinary medical education. One of

⁶³ *Zoonoses and communicable diseases common to man and animals, Vols I-III*, (Third Edition). (2003). Acha, P.N. and B. Szyfres, eds., Scientific and Technical Publication No. 580. Washington, DC: Pan American Health Organization, Pan American Sanitary Bureau, Regional Office of the World Health Organization, , D.C.

⁶⁴ U.S. Centers for Disease and Prevention. (n.d.). Emerging and zoonotic diseases—at a glance. Retrieved from www.cdc.gov/ncezid.

the required standards for accreditation includes: “The college must demonstrate substantial research activities of high quality that integrate with and strengthen the professional program.”⁶⁵

Accredited colleges meet this standard in a variety of ways, including didactic curriculum, research externships, and other specialized instruction. Nineteen colleges offer a dual DVM/PhD degree.⁶⁶ Of these, only one, the University of Pennsylvania School of Veterinary Medicine, receives NIH MSTP funding. A number of schools have established their own Veterinary Student Training Program (VSTP), using their own endowment funding. The high cost of providing such training precludes developing a significant workforce parallel to MD/PhD tracks.

Training grants available from the NIH Office of Research Infrastructure (ORIP) Division of Comparative Medicine to support the development of veterinarian-scientists include Postdoctoral Programs (T32), Predoctoral Programs (T32), and Summer Programs for Veterinary Students (T35). Seventeen veterinary programs currently have a postdoctoral T32 grant, five have a predoctoral T32 grant, and 15 have a T35 grant. Currently, only one VMD/PhD program (University of Pennsylvania) shares an MSTP T32 grant with the MD/PhD program at the same institution. Funding, however, has been flat for many years.⁶⁷

Individual training grants for early career investigators, specifically K01 and K99/R00 awards, are also available from the Division of Comparative Medicine within ORIP. (See Figure 2-3 for a brief description of these NIH training grants.) Funding available for this program has also not increased for many years.

The Merial Veterinary Scholars Program, whose mission is to expose veterinary students in their first or second year of veterinary school to biomedical research and career opportunities in research is often used to augment the NIH T35 program. Participating students spend 8 to 12 weeks during the summer in a mentored research experience at a participating veterinary school. Students have an opportunity to present their findings at the Merial-NIH National Veterinary Scholars Symposium (partially sponsored by an NIH R13 award). The 2013 symposium was attended by students from 38 participating veterinary colleges in North America and Europe and included 456 students and had a total attendance of 600.

Evaluation of outcome data from three institutions with longstanding DVM-PhD training (UPenn, Cornell, UC Davis) indicate that approximately 60 percent of postgraduate dual degree students enter academic careers, and a substantial portion of these individuals enter fields focused on clinical or translational research of interest to NIH. This trend is parallel to outcomes for MD-PhD trainee entry into the biomedical workforce arena, though as noted above, the lack of dedicated MSTP funding for DVM/PhDs has significantly limited development of these programs.

Qualitative Research Findings Related to Veterinary Students

Qualitative research about the training of veterinary scientists included two focus groups, one with seven DVM students and one with five DVM/PhD students, as well as an interview with the dean of one school of veterinary science that offers a DVM/PhD degree.

⁶⁵ <https://www.avma.org/ProfessionalDevelopment/Education/Accreditation/Colleges/Pages/coe-pp-requirements-of-accredited-college.aspx>

⁶⁶ http://veterinary-schools.findthebest.com/d/d/DVM_-_Ph.D

⁶⁷ NCRR, 2008

Only one of the seven participants in the DVM-only focus group expressed a specific interest in conducting research. The others entered veterinary school seeking to pursue clinical careers caring for animals; some became more interested in research as a result of their academic training.

In general, these students believed that a DVM degree should be a sufficient credential to do research, and believe that research can be incorporated into clinical practice setting. At the same time, they felt frustrated that research organizations wanted individuals who also had a PhD degree. They also found that the additional training time required to earn a PhD was a daunting prospect and were anxious to begin working so that they could pay off their student loans, which they consider out-of-proportion to veterinary salaries. An accelerated DVM/PhD program was recommended as one alternative.

DVM students would also like to have opportunities to work with medical students. There is a direct relationship between human medicine and animal medicine research, but little is taught to either group about the concept. They also recommended earlier exposure to veterinary research programs be developed to encourage greater student interest.

The DVM/PhD students felt there was little to no support or guidance for someone looking to pursue a research career. The prevailing feeling was that veterinary schools were not equipped to help graduates move on to a research career after finishing a combined DVM/PhD. Further, there was a perception that there are not many opportunities in veterinary research.

The dean of a veterinary science school who participated in the qualitative research estimated that 10-20 percent of students are interested in a research career. He cited the lack of research mentors and high levels of student debt as factors in students' decisions not to pursue a research career. He noted that there is only one MSTP program funded for veterinarians and urged more funding for veterinary dual degree programs, as well as greater access to the Loan Repayment Program for veterinarians.

Veterinary-Scientists as Participants in the NIH-Funded Workforce

Veterinarians are an overlooked component of the physician-scientist workforce. This is despite three NRC reports within the last 10 years concluding that the veterinary workforce is underrepresented and under-utilized in the biomedical research arena, and that veterinary recruitment and training is not providing a fertile ground for capitalizing on this opportunity.^{68,69,70}

From 1990 through 2002, live, vertebrate animal-based research accounted for approximately 43 percent of the research grants competitively funded annually by NIH, as shown in the figure below. However, since the mid-1990s, the total number of research grants has increased, resulting in a 31.7 percent increase in the number of competitive grants utilizing animals between 1995 and 2002. In essence, there were approximately 1,300 more competitive grants utilizing animals funded in 2002 than in 1995.

⁶⁸ National Research Council (2004). (US) Committee on Increasing Veterinary Involvement in Biomedical Research. *National need and priorities for veterinarians in biomedical research*. Washington (DC): National Academies Press.

⁶⁹ National Research Council. (2005). Committee on the National Needs for Research in Veterinary Science. *Critical needs for research in veterinary science*. Washington (DC): National Academies Press.

⁷⁰ National Research Council. (2013). *Workforce needs in veterinary medicine*. Washington, DC: The National Academies Press.

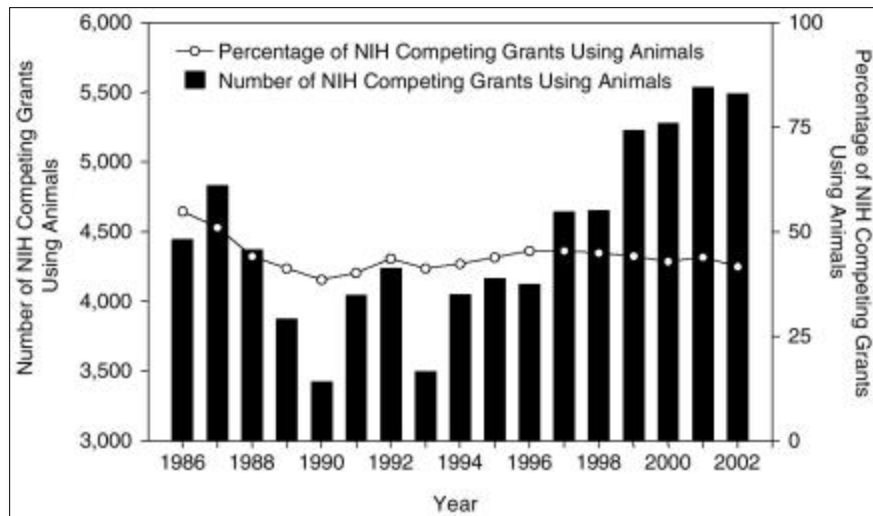


Figure 5.1. Historical Trends of Animal Use in NIH Grant Portfolio (1986-2002)⁷¹

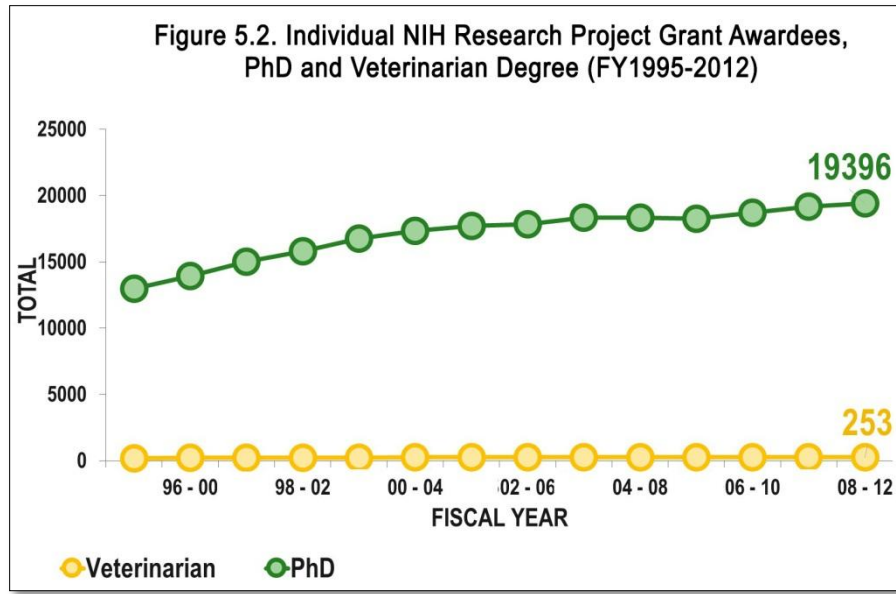
Despite the central role that veterinary expertise can bring to biomedical research teams, veterinarians are often overlooked when collaborative biomedical research teams are being formed. This factor is perhaps the greatest impediment for veterinarians entering the physician-scientist workforce.

The Size and Composition of the Veterinarian-Scientist Workforce

The PSW-WG analysis indicates that in 2008-2012, approximately 250 veterinarians were funded by NIH (Figure 5.2). To provide some context, there are 4000 veterinarians employed as academic faculty at schools and colleges of veterinary medicine, according to the American Veterinary Medicine Association.⁷² Thus, the PSW-WG estimates that veterinarians comprise approximately three percent of the total NIH-funded physician-scientist workforce.

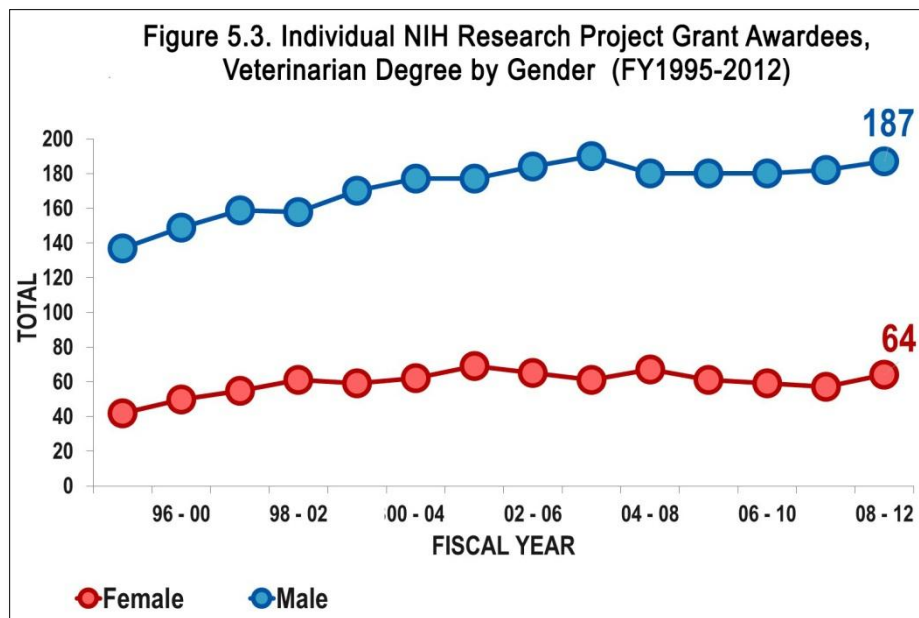
⁷¹ NRC (2004), p. 18

⁷² NRC (2013), *ibid.*

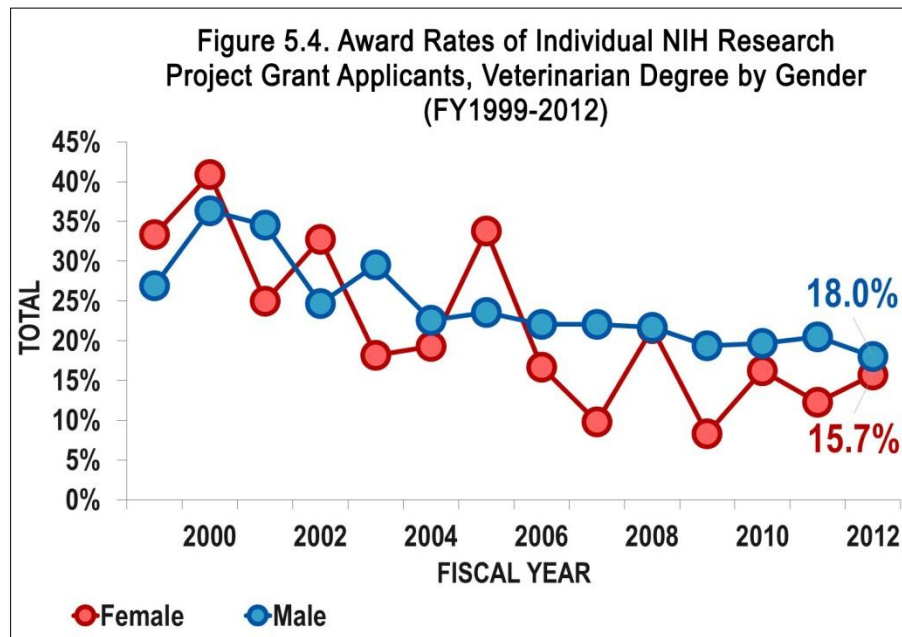


Gender

Among veterinarian-scientists who receive RPGs from the NIH, men outnumbered women by about three to one, as shown in Figure 5.3.



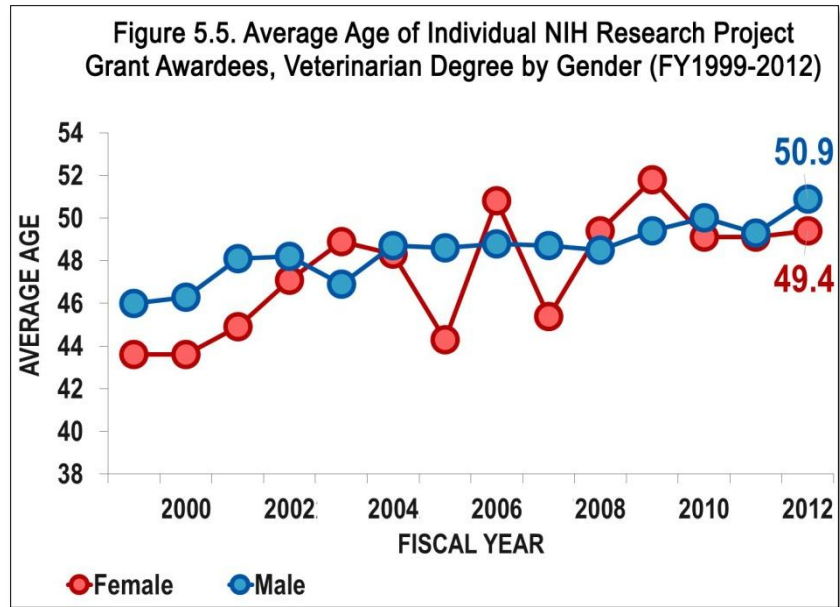
Women comprise about 90 percent of students in veterinary schools.⁷³ The award rate for RPGs was not significantly different for females in 2012 ($p=0.59612$) (Figure 5.4).



Age

In 2012, the average age of a veterinarian RPG grant holder was 50.4 years, as seen in Figure 5.5. (In comparison, the average age of MD RPG grant holders was 51 years; for MD/PhDs, 51.8 years, and for PhDs, 48.3 years.

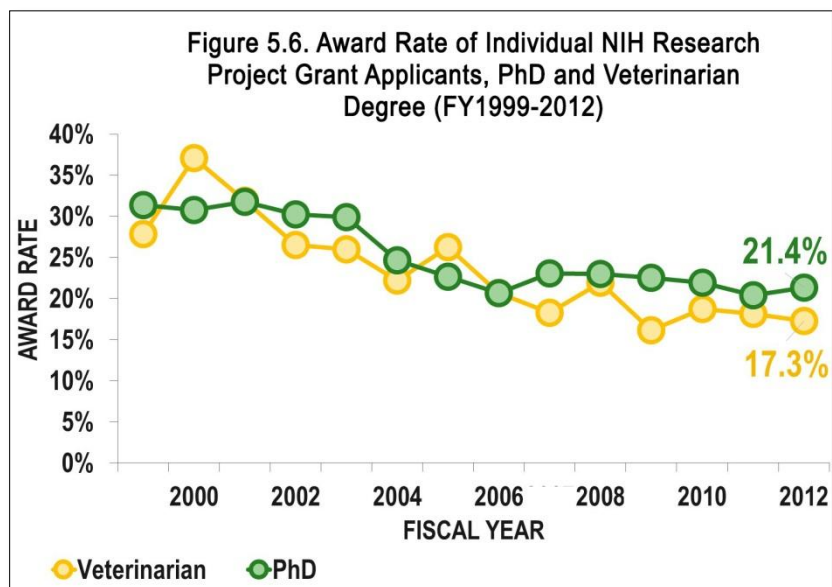
⁷³ JustVetData. (2013). *Meet the pink elephant in the room: Gender in veterinary medicine*. Retrieved from http://www.justvetdata.com/meet_the_pink_elephant_in_the_room_gender_in_veterinary_medicine



The average age of first-time veterinarian applicants for a research award is 45.5. In contrast, the average age of **First Time** RPG awards for MDs was 45.2 years, for MD/PhDs, 44.3 years, and for PhDs, 41.9 years.

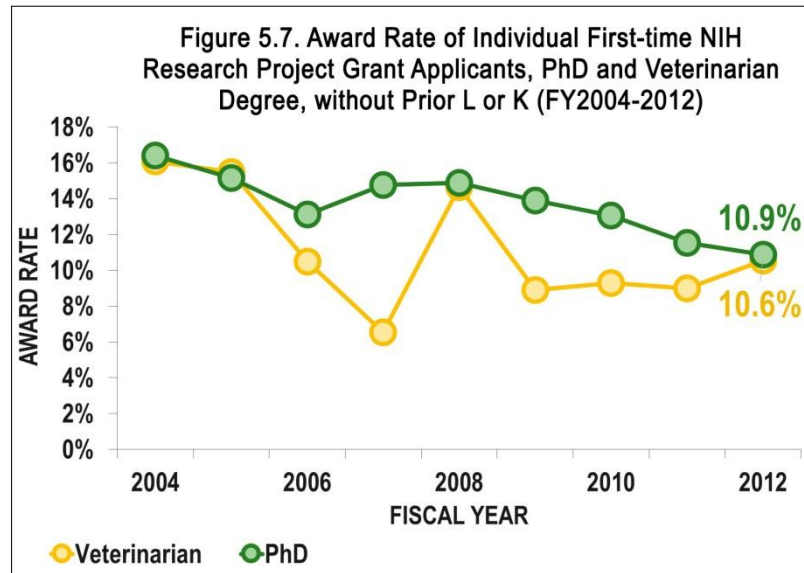
NIH RPG Rate

Of those veterinarians who applied for NIH funding, the award rate has remained below 20 percent during the past five years (see Figure 5.6). Award rates for MDs and MD/PhDs were significantly higher (see Chapter 3).

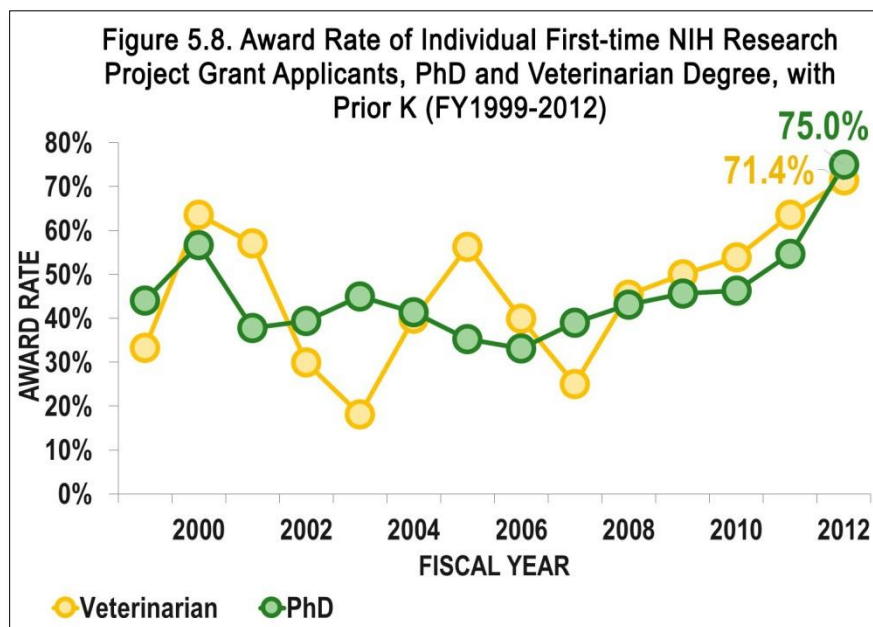


Effects of Early Career NIH Programs on Veterinarian-Scientists

The number of veterinarians participating in the MSTP program and the LRP awards is so low that the data are not included here. Similarly, the number of veterinarian-scientists who receive K awards is small and declining, as shown below in Figure 5.7.



Similar to trends noted for larger numbers of MD scientists, those veterinarian-scientists with a K award compete quite successfully for R01 awards (Figure 5.8), compared to those without a K, as seen in the next two figures.



These findings suggest the key importance of the K award in fostering research excellence in veterinary medicine.

Summary of Challenges Facing the Veterinarian-Scientist Workforce

Challenges faced by the veterinary physician-scientist workforce include:

- **Recruitment**
 - Many veterinary students are not oriented toward research careers, and the general public does not associate veterinary training with advances in or contributions to medical science.
- **Training**
 - Veterinary students encounter few research-oriented mentors and role models during their years in veterinary school.
 - Veterinary students typically graduate with high levels of student debt (average=\$162,113)⁷⁴ and are rarely eligible/encouraged to participate in NIH loan repayment programs.
 - Public, private, and governmental entities do not consider the versatility of veterinary education and training relative to pressing societal needs such as global food security, animal model utilization for development and testing of novel therapies, emergent diagnostics, genetic disease and therapies, etc. Without raised awareness of veterinary capabilities in this area, it will be difficult to change recruitment priorities or paradigms to result in a research-capable veterinary workforce.
 - NIH funding for pre-doctoral training programs supporting training of veterinarian-scientists has been flat and MSTP-like programs are generally not available to veterinary colleges.
 - Veterinary curriculum does not typically promote the role of the veterinarian-scientist.
- **Retention**
 - Colleges of veterinary medicine and/or veterinarians do not always qualify for or capitalize on NIH and other federal research awards.
 - There is no single Institute or Center at NIH focused on veterinary research following the dissolution of the NCRR in 2011.
 - Employment in public health or academic research is a demanding career that often provides less salary support than private sector private practice positions.
 - Though there is the perception that veterinarians are less successful at competing for NIH RPGs than MDs and PhDs, the differences in funding rates for veterinarians are only modestly lower than PhDs. The factors contributing to this discrepancy have not been determined.

⁷⁴ The mean educational debt among the 90 percent of respondents to the AVMA's 2013 survey of veterinary school graduates. The figure increased 7 percent from 2012. Sixteen percent of respondents had a debt load of \$230,000 or greater; only 1 percent of respondents reported a debt load of less than \$10,000; and 10 percent reported having no debt. (source: dvm360, V 45 (2), Feb 2014)

Specific Recommendations for the Veterinarian-Scientist Workforce

Most of the recommendations that impact veterinarian-scientists may be found in [Chapter 7](#). The following recommendations are unique to veterinarian-scientists and responsive to the challenges identified above.

1. NIH should encourage inclusion of veterinarian-scientists in the review and as team members for applications relying on use of vertebrate animals.
2. NIH should highlight the availability of F30 and F31 awards for DVM/PhD training, and should expand MSTP programs to allow DVM/PhD institutional training awards. K award program expansion for veterinary scientists should be encouraged, given the positive association between K award and RPG success.
3. In light of the enormous percentage of veterinary school graduates who are women, NIH should consider developing innovative programs to encourage female veterinary students and female veterinarians to join the physician-scientist workforce. As part of this effort, NIH should evaluate parameters relating to poorer RPG application rate by veterinarian-scientists, and particularly success by female veterinarian-scientists.

Chapter 6

Dentist-Scientists

It was at the beginning of the last century that dentists sought to transform a respectable craft into a science-based profession by boldly aligning with institutions of higher learning. Discoveries by dentist-scientists have transformed fields of medicine. For example, in 1952, a dentist-scientist named Norman Simmons designed the techniques for isolating pure DNA that made it possible for Rosalind Franklin to create the first x-ray crystallography images of DNA. This led to the prediction of the structure of DNA by James Watson, Francis Crick, and Maurice Wilkins in 1953. In the post-World War II era, dentist Robert Ledley pioneered computerized tomographic scanning and 3-dimensional imaging that led to the development of modern diagnostic imaging for both dentistry and medicine. In the late 1960's, the work of another dentist-scientist, Russell Ross, and his colleagues advanced our understanding of the molecules involved in wound healing and proved that atherosclerosis is an inflammatory disease.

Dentist-scientists are committed to the development of new therapeutics and therapies for common and rare diseases and disorders that affect craniofacial tissues. Investigators most committed to this field of inquiry will come from the ranks of faculty and students in dental schools across the US. Hence, the training of dentist-scientists and the development of academic faculty with research training are critical components of strengthening the dentist-scientist workforce.

Training of Dentist-Scientists

There are 65 dental schools in the United States, according to the American Dental Education Association. Eighteen of these schools offer a dual degree program; an additional 10 schools offer a PhD in oral biology, oral health, or oral science.^{75,76} The National Institute of Dental and Craniofacial Research (NIDCR) currently funds 19 institutions with T32 or T90/R90 awards. Of these, 13 offer a dual DMD or DDS/PhD degree and 9 provide support for PhD or postdoctoral training for non-U.S. citizens and/or permanent residents.⁷⁷

Dual degree programs are relatively new in dental education; traditionally, dental education has been primarily focused on the clinical preparation of students who receive little exposure to research during their dental education. As a result, a 2004 survey of more than 4,000 dental school graduates by the American Dental Education Association found that only 0.5 percent had plans to focus on teaching or research.⁷⁸

DDS/PhD programs typically take 6 to 8 years to complete and the number of students enrolled in each program is small, 1-2 students per year.⁷⁹ Students enrolled in these programs typically graduate with less debt than other dental school graduates, due to the availability of NIH training funds. However, the integration between scientific and clinical training is often poorly defined in these programs with incongruent clinical and scientific program requirements that may be challenging for students to resolve.

⁷⁵ <http://forums.studentdoctor.net/threads/the-official-dds-phd-or-dmd-phd-thread.987946/>

⁷⁶ Roger. J.M. (2006). A survey of dual-degree training opportunities at U.S dental schools. *Journal of Dental Education* 70(9), 909-917..

⁷⁷ NIDCR. National Research Service Award Institutional Research Training Grants (T32 or T90/R90). <http://www.nidcr.nih.gov/CareersAndTraining/Fellowships/Institutions/ParticipatingInstitutions/>

⁷⁸ Roger, *ibid*.

⁷⁹ *Ibid*.

In addition, there are few senior faculty mentors available to DDS/PhD trainees, and few dentist-scientist role models.

Following completion of DDS/PhD programs, most graduates enter specialty training or private practice. Consequently, the number of DDS/PhD scientists entering the dentist-scientist workforce is relatively low.

An additional barrier to the recruitment of more DDS/PhD candidates is the absence of a centralized information source where prospective students can learn about available programs, application requirements, and research career opportunities.

Qualitative Research Findings Related to Dentist-Scientists

Qualitative research about dental students included one focus group of 6 dental students as well as interviews with the deans of two dental schools, one of which was research-intensive. In addition, one DDS/PhD candidate participated in a focus group where other participants were DVM/PhD candidates.

Among the non-PhD dental students, most reported that they chose dental school because they were interested in patient care and wanted to own their own business. Although students reported some limited exposure to research during their undergraduate years, none applied to dental school with a research career in mind. They also expressed uncertainty about how a career in dentistry and research could be achieved. Most did not think it should be necessary to get a PhD and were not interested in pursuing additional training due to the length of such research programs and the high amount of student debt they were carrying.

The overriding sentiment among students in this group was that they chose dentistry because it is a high-paying profession in which individuals in private practice can own their own business, control their own hours, and hence create a desirable lifestyle.

When pressed to suggest initiatives that would make a research career more attractive, these students identified:

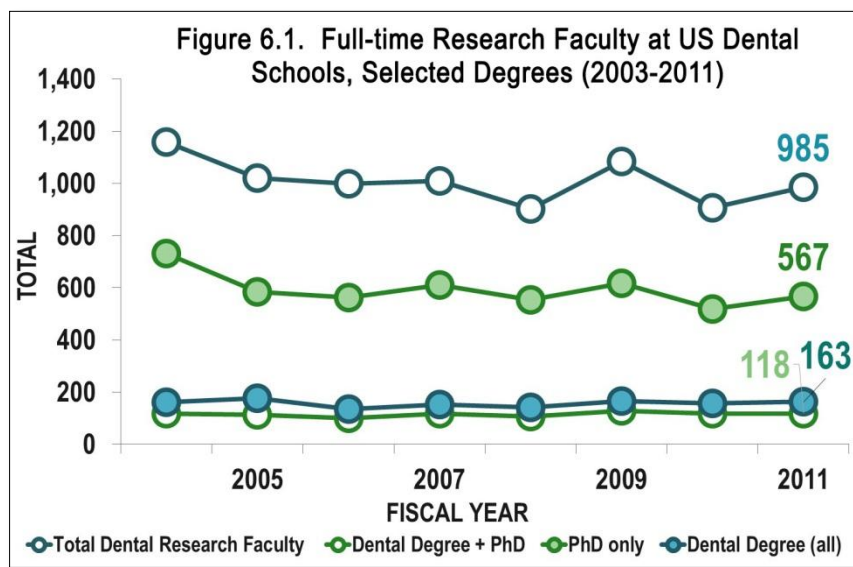
- Greater networking opportunities and better knowledge of NIH opportunities as they relate to dentistry. Webinars, listservs, and conferences as vehicles for learning more about NIH opportunities
- Early (including pre-dental school) exposure to dental research programs, particularly information on funding opportunities for school/training
- More publicity about loan repayment options for research careers that are currently available
- More networking and travel funds
- More concise training periods for better integrated dual DDS/PhD Program

The dental school deans confirmed that interest in a research career was low among dental students; one estimated less than 2 percent of students were interested in research. Lack of early exposure to research, lack of dentist-scientist role models, low salaries for academic researchers, and high levels of student debt were cited as factors deterring students from considering a career in dental research.

Dentist-Scientists in the NIH-funded Workforce

Size and Composition of the Dentist-Scientist Workforce

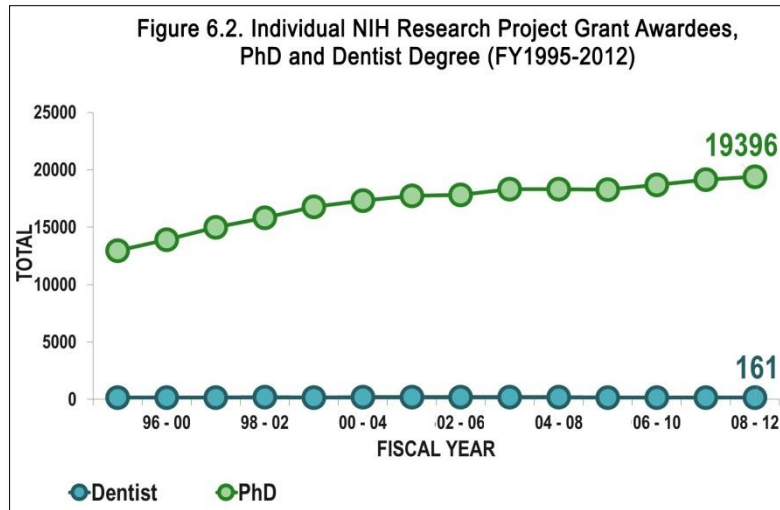
Approximately 1000 individuals are full-time research faculty in dental schools, spending 80 percent or more of their time doing research. Over half of these faculty members hold a PhD, 163 hold a professional dental degree, and 118 hold a DDS or DMD/PhD. Figure 6.1 illustrates these findings.



Source: American Dental Education Association's Comprehensive Faculty Survey (Annual); Primary Appointment: Research is defined as faculty who spent more than 80 percent of their time in research related activities.⁸⁰

In 2012, 161 dentist-scientists were awarded an RPG from NIH (see Figure 6.2).

⁸⁰ A select number of other degree holders are not shown, so the PhDs, DDS/PhDs and Dental Degrees (all) will not total the Total numbers.

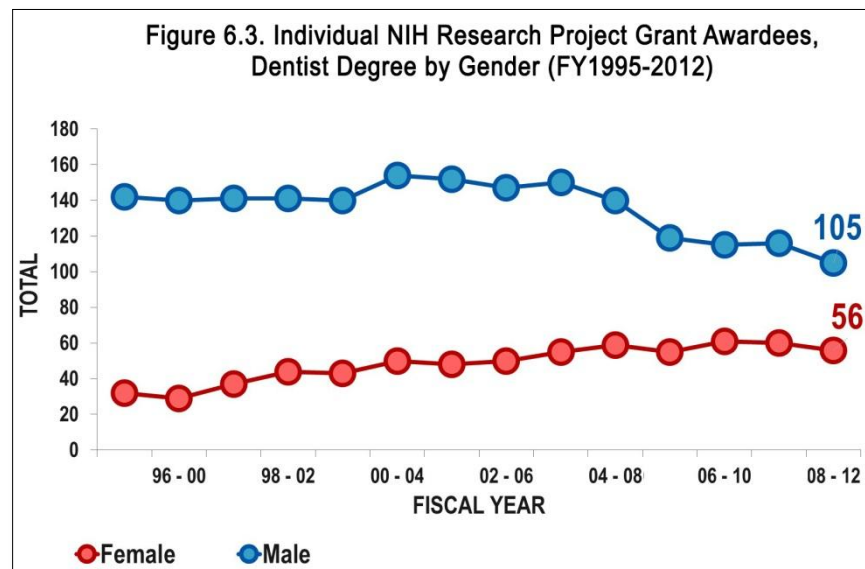


Data were aggregated over 5 year windows to reduce double counting of individuals who apply multiple times or were awarded multiple grants during that window.

Thus, the PSW-WG estimates that approximately two percent of the NIH-funded physician-scientist workforce are dentists.

Gender

Among professionally active dentists, men outnumbered women almost 3 to 1 in 2012.⁸¹ That same year, female dentist-scientists received almost one-third of the RPGs awarded, i.e., a disproportionately high amount, as shown in Figure 6.3.

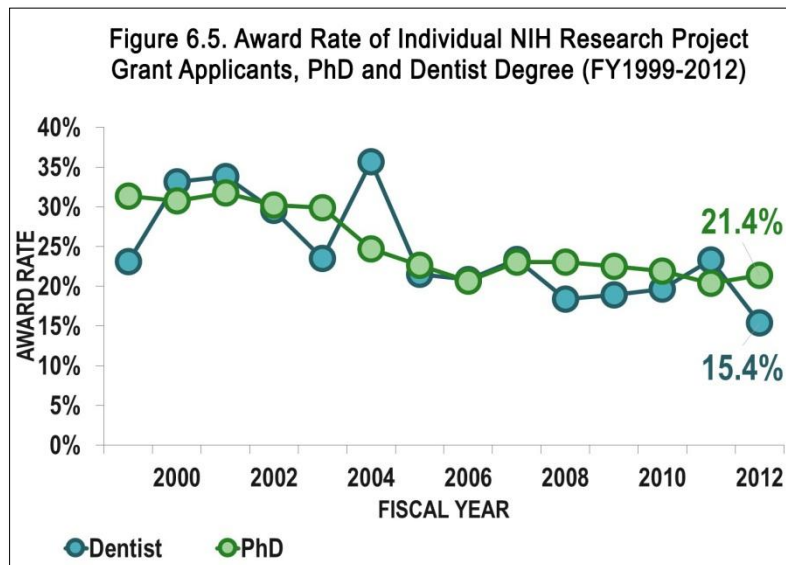
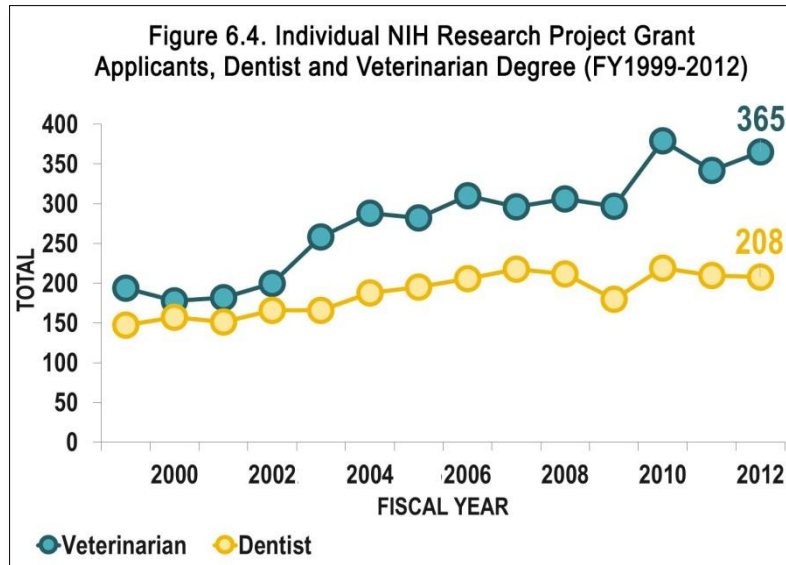


Data were aggregated over 5 year windows to reduce double counting of individuals who apply multiple times or were awarded multiple grants during that window.

⁸¹ <http://kff.org/other/state-indicator/total-dentists-by-gender/>

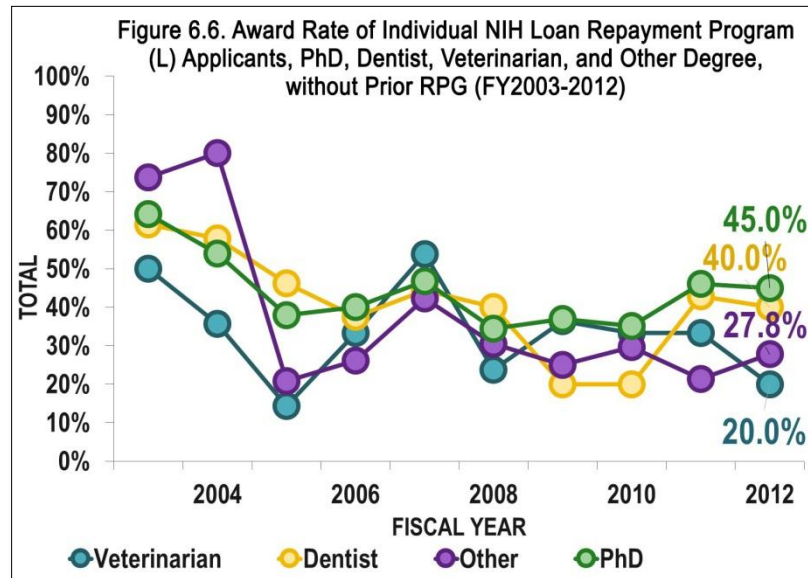
NIH RPG Award Rates

Between 1999 and 2012, there was a 41 percent increase in the number of dentist-scientist applicants, versus an 88 percent increase from veterinarian-scientist applicants (Figure 6.4). Despite the increase in applicants, the number of awards made annually to dentists remained relatively constant, attributable to the decreasing award rate among dentists which went from a one time high of 35.6 percent to the most recent rate in 2012 of 15.4 percent, as shown in Figure 6.5.

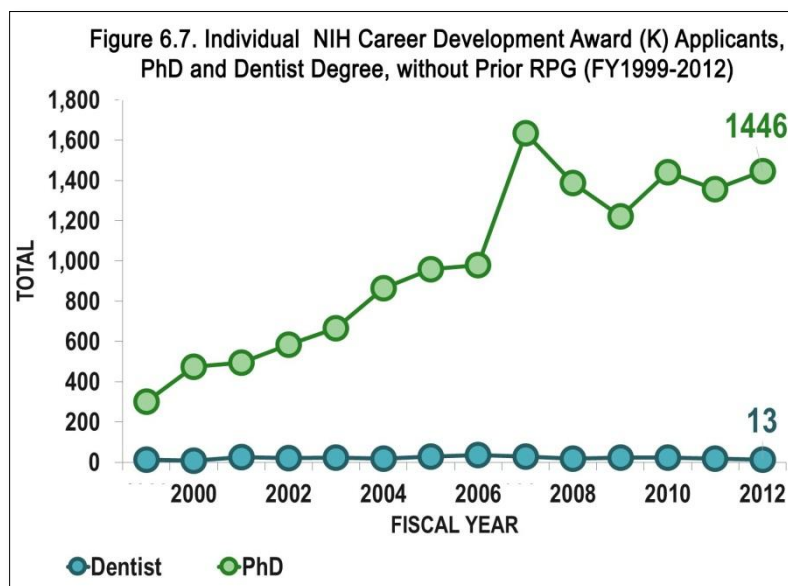


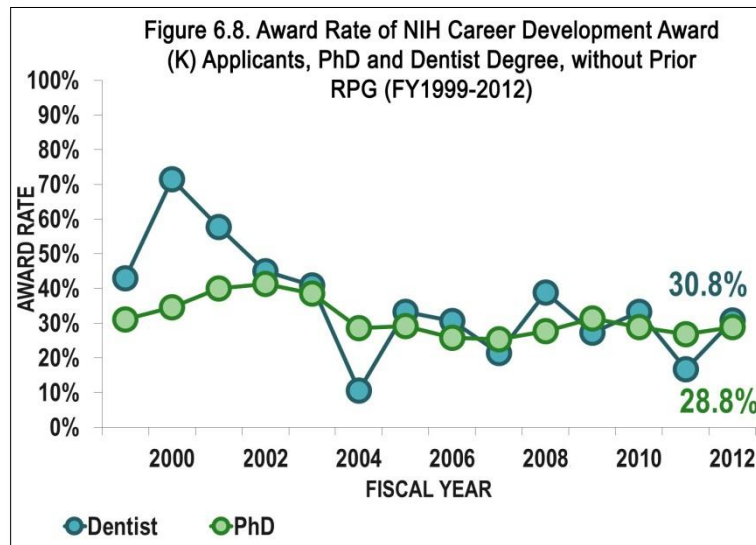
Participation in Early Career NIH Programs by Dentist-Scientists

The number of dentists participating in the LRP awards is so low that the data are not included here. The annual award rates vary because of the small numbers, but in general have gone from better than 40 percent from 1999-2001, to a range of 20-40 percent more recently (Figure 6.6). This is clearly a potential resource for encouraging research in junior dental faculty that has been underutilized.



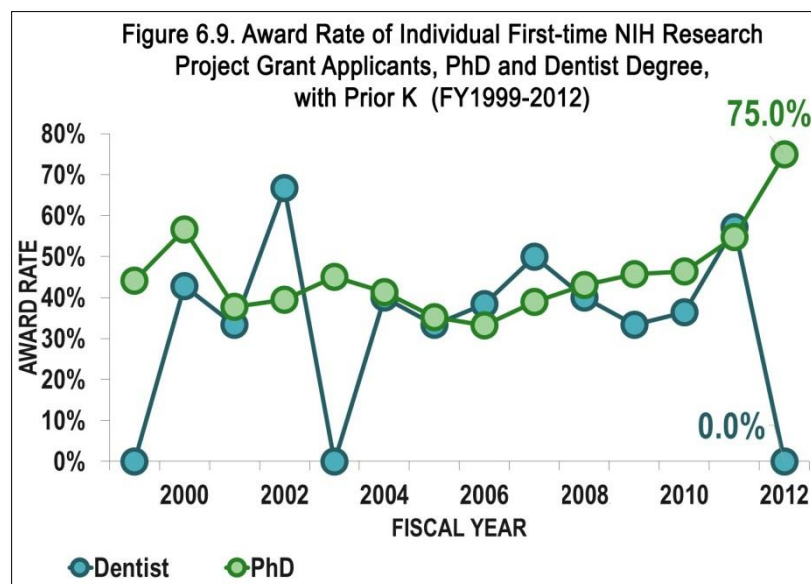
In 2012, the number of applicants for K awards from dentists was 13, a substantial decrease from a high of 36 applicants in 2006 (Figure 6.7). In 2012, the award rate for K awards among dentist-scientists was 30.8 percent, as seen in Figure 6.8.





Effects of Early Career NIH Programs on Dentist-Scientists

The number of dentist-scientists with L or K awards is so small that meaningful interpretation of the data is not possible. Despite the small numbers, the award rate of first-time RPG dentist-scientist applicants who had a prior K award appear higher than the award rate of first-time RPG dentist-scientist applicants who have not had a prior K award.



Summary of Challenges Facing the Dentist-Scientist Workforce

A significant concern in dental education is the number of vacant faculty positions; in 2003-2004 there were an estimated 241 vacant full-time and 55 part-time faculty positions at U.S. dental schools.⁸² Foreign-trained dentists who have received advanced specialty training in the United States are a prime source for filling these positions. These individuals often have less student debt than U.S.-trained dentists, view faculty positions as prestigious, and can more easily practice dentistry as a faculty member without the more burdensome prerequisites for private practice. However, many lack research training and are usually not eligible for NIH training support programs because of citizenship status.

The primary source of faculty in U.S. schools of dentistry is U.S.-trained dentists with specialty or advanced clinical training. However, many of these individuals carry high educational debt loads making academic salaries unappealing in comparison to clinical practice. Those who do pursue academic appointments frequently become excellent clinical teachers, but often contribute little to research due to lack of research training and minimal expectations by their institutions. Financial pressures on dental schools also resulted in an increased emphasis on clinical revenue generation, thereby relaxing the emphasis on research. Further, once hired, young faculty members have difficulty finding senior faculty with the appropriate research background to mentor them during their early career years.

Non-DDS faculty, those with MS and/or PhD degrees, have often provided research training and mentoring in dental schools. These individuals can pursue their research interests without conflicting teaching and clinical service commitments. However, this valuable pipeline of committed researchers is rapidly dwindling for academic dentistry due to shifts in priorities away from research within dental schools and difficulties in succeeding with R01-level research.

Several factors threaten the biomedical workforce of dentist-scientists. These include:

- A low priority given to research within dental schools: An overwhelming majority of the 13 new schools that have launched in the past 15 years can be classified as non-research-intensive.
- There has been a gradual decline of research productivity in dental schools, in general. This has resulted in the lack of competitiveness of dental school-based researchers for NIH funding. For example, the percentage of NIDCR funding to dental schools has declined from 68.7 percent to 46.7 percent between 1993 and 2008 and this downward trend continues.⁸³
- The last decade has seen an upward trend in income levels for dentists in the private sector. The significant differentials seen in compensation with academic salaries has led to a highly competitive pool of dental applicants who are more drawn to private practice careers.
- As commitments to research have declined in more established dental schools, the new dental schools have developed tuition-based financial plans that are driven by non-research intensive training programs.

⁸² Weaver, R.G., Car, J.E., Haden, N.K., Valacovic, .RW. (2005). Dental school vacant budgeted faculty positions: Academic year 2003-04. *Journal of Dental Education* 69: 296-30.

⁸³ Lipton, J.A. & Kinane, D.F. (2011). Total NIH support to U.S. dental schools, 2005-2009. *Journal of Dental Research*, 90(3) : 283-288.

- The average dental student debt burdens have risen to alarming levels; current loan values are approximately \$220,000.⁸⁴ While ADEA and ADA are brainstorming strategies for loan repayment, these mechanisms are not in place currently. This has profound effects on the retention of dentist-scientist in the biomedical workforce.
- Research in the oral health sciences has steadily built in medical schools/hospitals, schools of engineering, etc. further contributing to a disengagement from research within dental schools.
- Taken together, the culture and environment within dental schools has led to a diminished pool of research faculty mentors for dentist-scientist trainees, the lack of understanding and support for the training and career development of dentist-scientist graduates and a transition away from the granting of tenure.

Specific Recommendations for the Dentist-Scientist Workforce

Most of the recommendations that impact dentist-scientists may be found in [Chapter 7](#). The following recommendations are unique to dentist-scientists and responsive to the challenges identified above.

- Encourage/incentivize promising dental school graduates to consider careers in developing team science perhaps by creating post/doctoral fellowships-faculty transition plans at their school- with post-doctoral fellowships to be performed at leading centers for team science.
- NIH should partner with the American Association for Dental Research and the American Dental Association in efforts to emphasize Evidence-Based Dentistry and in providing access to short term training in research methodology for dental faculty.
- NIH should partner with ADA and other professional dental organizations to develop a 'prescribed program' with 'best practices' for training DDS/PhD researchers.

⁸⁴ 2013 ADEA President's Report: Looking Around the Corner. Retrieved from http://www.adea.org/ADEA/Content_Conversion/about_adea/2013_ADEA_President_s_Report__Looking_Around_the_Corner.html

Chapter 7

Recommendations

A number of forces outside the NIH pose great challenges to the future PSW including:

- changes in the funding and practices of academic medical centers
- dramatic shifts in the economics of medicine and healthcare
- rising educational debt
- increasing length of training
- growth in the regulatory burdens required to maintain clinical practice
- challenges to the overall quality of Science, Technology, and Mathematics (STEM) education in the United States, and
- changing immigration policy affecting a significant component of the physician-scientist workforce.

Wherever possible, NIH should engage with appropriate other private and public agencies to address these larger societal issues. Here, we will provide our specific recommendations regarding what NIH can directly do to enhance and maintain the physician-scientist pipeline and workforce.

Although the absolute number of physician-scientists has declined only slightly over the past decade, the workforce is progressively aging. The number of new physician-scientists entering the workforce is falling, as reflected in the reduced numbers of applicants for early career (K and LRP) awards over the last 5 years. These data presage a decline in the physician-scientist workforce as the current cohort of senior physician-scientists retires. Our key recommendations thus focus on the early stages of the pipeline, on enhancing the ability of the NIH to evaluate the relative effectiveness of its programs to build and maintain the pipeline, and on systematically collecting and reviewing data so the biomedical workforce can more easily and readily be assessed.

The recommendations outlined below should be extended to all clinically-trained scientists, including veterinarian-scientists, dentist-scientists, and nurse-scientists. Recommendations that are specific to a given segment of the workforce may be found in the previous chapters.

Recommendations

The following recommendations apply to all clinically-trained investigators, including veterinarian-scientists, dentist-scientists, and nurse-scientists.

1. **NIH should sustain strong support for the training of MD/PhDs.** MD/PhD programs (including the Medical Scientist Training Program [MSTP] program funded by NIH) have been successful in promoting the development of physician-scientists and should be continued.
2. **NIH should shift the balance in National Research Service Award (NRSA) postdoctoral training for physicians so that a greater proportion are supported through individual fellowships, rather than institutional training grants.** The number of individual fellowship awards for MD-PhD students (F30/F31 grants) should also be increased. The PSW-WG endorses the similar recommendation from the Biomedical Workforce Working Group that support for both pre- and post-doctoral PhD trainees and individual fellowship for MD/PhD trainees should be expanded. It is critical to obtain accurate long-term follow-up on trainees through all of these

programs to assess comparative effectiveness. These results should guide future allocation of NIH funds to these various mechanisms.

3. **NIH should continue to address the gap in RPG award rates between new and established investigators.** Although NIH policies have narrowed the gap for new RO1 applicants, this problem remains significant and needs continued attention. A number of pilot approaches should be explored, and rigorously assessed, with the most successful given expanded support (also see #7 below).
4. **NIH should adopt rigorous and effective tools for assessing the strength of the biomedical workforce, including physician-scientists, and tracking their career development and progression.** NIH should collaborate with external organizations that also have a strong investment in workforce development to collect, monitor, and report on key indices related to workforce issues. Specifically, NIH should establish an ongoing workgroup of NIH employees and external partners to support the development of a Biomedical Workforce Dashboard application that provides real-time tracking of the career development and progression of the workforce. The Dashboard would be a tool that both NIH employees and the public could use to instantly answer questions related to important workforce issues at the agency or I/C level.
5. **NIH should establish a new physician-scientist-specific granting mechanism to facilitate the transition from training to independence.** This program should be similar to the K99/R00 program whose funding currently goes almost exclusively to individuals holding a PhD degree. This new grant program could serve either as a replacement or transition from existing K Awards for physician scientists, and should provide a longer period of support, potentially lengthening the R00 phase to 5 years (with an interim staff review at year 3). This new grant series, as well as K and all other training awards, should rigorously enforce protected time of at least 75 percent effort and provide sufficient salary support to make that possible.
6. **NIH should expand Loan Repayment Programs and the amount of loans forgiven should be increased to more realistically reflect the debt burden of current trainees.** This program should also be made available to all students pursuing biomedical physician-scientist researcher careers, regardless of particular research area or clinical specialty.
7. **NIH should support pilot grant programs to rigorously test existing and novel approaches to improve and/or shorten research training for physician-scientists.** These programs should include (but not be limited to) mechanisms to shorten medical and/or laboratory training, explore timing and spacing of the research and clinical components of post-graduate training, and other alternatives. New opportunities for training in informatics and social science research that address emerging needs of the health care system should also be evaluated. Those programs exhibiting the most promising results should receive expanded support.
8. **NIH should intensify its efforts to increase diversity in the physician-scientist workforce.** This Working Group recognized major deficiencies of the physician-scientist workforce with regard to diversity. The PSW-WG strongly endorses the previous recommendations of the preceding biomedical workforce Working Group and the Working Group on diversity, all of which should be extended to the physician-scientist workforce.
9. **NIH should leverage the existing resources of the Clinical and Translational Science Awards (CTSA) program to obtain maximum benefit for training and career development of early-career physician-scientists.** This process should include critical review and analysis of rigorous outcome data, as outlined in #7 above.

Recommendations specific to each segment of the non-MD workforce ([nurse-scientists](#), [veterinarian-scientists](#), and [dentist-scientists](#)) may be found in Chapters 4 through 6.

Appendix 1

Physician-Scientist Workforce Working Group Subcommittees

	Clinical Research PS	Lab Research PS	Non MD PS	Data
Chairperson	G. Bernard	H. Hobbs	R. D'Souza S. VandeWoude	T. Ley L. Rosenberg
PSW WG Members	S. Shurin V. Lee D. Nichols A. Knebel E. Larsen	D. Ginsburg N. Andrews J. Merchant A. Schafer	S. Mills J. Fox	S. Mills L. Brass R. Lifton D. Meltzer
Ad Hoc Members	Robert Califf Barry Collier Thomas O. Daniel Robert Dittus	Mark. C. Fishman Donald Ganem Peter Gruber Mike J. Welsh	<u>Dental</u> Tim DeRouen Mildred Embree Jeffrey Myers <u>Vet</u> Harry W. Dickerson Michael Lairmore Willie M. Reed	Janine Clayton

Appendix II: Quantitative Analysis Methodology

During the process of supporting the PSW working group, in particular the PSW data subcommittee, Thomson Reuters designed and built a reporting system that facilitated the many data requests from the subcommittees. A first step was to work closely with the PSW working group and NIH staff to define the analysis requirements and identify data sources. Once the available data was collected and centralized in a database, the focus turned to the preferred delivery format. An automated reporting module was developed, one that queries the data system and produces tables and charts to committee specifications. The intent was to avoid a one-time, one-report process in favor of a data system that can facilitate future tracking and evaluation of any recommendations implemented by the NIH and other organizations in response to the findings of the PSW working group.

A key feature of the PSW data analysis is how it differs from standard data reporting at NIH, which normally focuses on reporting application and award total counts and breakdowns. Instead, PSW's unit of analysis is the individual: Each individual is tracked by the data system throughout the PSW pipeline to create a history of research outcomes. Hence, trends can be established for different groups of people (not just programs), and unique career tracks can be examined more carefully and compared to produce a better picture and understanding of the physician-scientist workforce.

Data Sources

Unless otherwise noted, the source of data for all charts and tables included in this report are from NIH's IMPACII data system, supplemented with AAMC Faculty Roster data, as provided under a data sharing agreement with AAMC. Aggregate data on faculty and physician-scientists were provided by the American Medical Association (AMA), the American Dental Education Association, the American Veterinary Medical Association and the Association of American Veterinary Medical Colleges.

Select reports were generated using data from the NIH Medical Scientist Training Program (MSTP) and summary data from the AAMC's Matriculating Student Questionnaire and Medical School Graduation Questionnaire. Aggregate data on faculty and physician-scientists were provided by the American Medical Association (AMA), the American Dental Education Association, the American Veterinary Medical Association and the Association of American Veterinary Medical Colleges.

In addition, data analyses were carried out with significant support from NIH's Division of Statistical Analysis and Reporting (DSAR) within the Office of Extramural Research. Specifically, DSAR staff provided data on T32 appointees' outcomes and other data review and analysis.

The NIH awards and time period selected for inclusion in the system from IMPACII were:

- Research Project Grants for the following 25 activity codes between 1993 and 2012, Type 1 applications, including subprojects: DP1, DP2, P01, P42, PN1, R01, R03, R15, R21, R29, R33, R34, R35, R36, R37, R55, R56, RL1, RL2, RL5, RL9, U01, U19, UC1, UC7
- L Applicants - 5 activity codes, between 2003 and 2012, Type 1 application, these include: L30, L32, L40, L50, L60

- K Applicants - 24 activity codes, between 1993 and 2012, Type 1 application, including subprojects, excluding K12, these include: K01, K02, K04, K05, K07, K08, K11, K14, K15, K16, K17, K18, K20, K21, K22, K23, K24, K25, K26, K30, K99, KL1, KL2, KM1
- AAMC Faculty Data (tenure track and non-tenure track) from their AAMC Faculty Roster (and MSQ/MSGQ) between 1993 and 2012
- MSTP program data between 1993 and 2012

Treatment and Disambiguation

As noted above, a key requirement for this analysis was to track individuals throughout the PSW pipeline at key career stages (i.e., a first-time RPG applicant RPG or, say, R01). Accordingly, a method was devised by Thomson Reuters to count individuals and their associated applications and awards on any given year during the time-period.

An individual applicant was defined as: in a given Fiscal Year, an individual applicant is counted only once per IC and mechanism. In the event an applicant applies more than once in a given FY to an IC and mechanism, the most recent awarded application is selected.

The approach used by the PSW data subcommittee differs from standard data reporting at NIH, which normally focuses on reporting application and award total counts and breakdowns. These differences may lead to discrepancies when comparing trends presented here to those reported for applications and awards.

Degree categories and assigned groupings (individuals could have more than one degree) were reviewed by the PSW data subcommittee, and the degree categories were set as:

Degree Category	Degree Grouping
PhD	PhD
	PhD/other
MD	MD
	MD/other
	MD/Dentist
	MD/Dentist/other
PhD/MD	PhD/MD
	PhD/MD/Dentist
	PhD/MD/other
	PhD/MD/Veterinarian
	PhD/MD/Dentist/other
	PhD/MD/Veterinarian/other
	PhD/MD/Veterinarian/Dentist
	PhD/MD/Veterinarian/Dentist/other

Degree Category	Degree Grouping
Veterinarian	PhD/Veterinarian
	Veterinarian
	PhD/Veterinarian/other
	MD/Veterinarian
	PhD/Veterinarian/Dentist
	Veterinarian/Dentist/other
	MD/Veterinarian/Dentist
	MD/Veterinarian/Dentist/other
	MD/Veterinarian/other
	PhD/Veterinarian/Dentist/other
	Veterinarian/Dentist
	Veterinarian/other
Dentist	Dentist
	Dentist/other
	PhD/Dentist
	PhD/Dentist/other
Other	Other
Unknown	Unknown

Appendix III: Data Definitions

DATA DEFINITIONS

IMPACII data reflects system updates as of September 13, 2013.

All counts in the tables and figures are by individual (applicants and awardees). ARRA/Recovery Act applications and awards are excluded.

UPDATE NOTES

Since completing the MSTP report, we now recognize T-grant prior support for individuals in all reports. As a result, the total counts of individuals with prior L support only (RPG Spreadsheet: 1.4.x and R01 Spreadsheet: 2.4.x), prior K support only (RPG Spreadsheet: 1.5.x and R01 Spreadsheet: 2.5.x), and prior L and K support only (RPG Spreadsheet: 1.6.x and R01 Spreadsheet: 2.6.x) have been updated and reduced to reflect this change.

The sliding year ranges in these reports consider windows of applications beginning 5 years prior to each fiscal year currently being considered. Because data for prior L-grant support are not available prior to 2004, the year ranges 2000-2004 through 2003-2007 do not contain a full five years of data.

Total columns for all sheets consider data from all years currently available, even though not all individual years are shown in the reports.

Totals for Age brackets were omitted.

RPG, L, K DEFINITIONS

Research Project Grants or RPGs include the following 25 activity codes between 1993 and 2012, Type 1 applications, including subprojects:

DP1, DP2, P01, P42, PN1, R01, R03, R15, R21, R29, R33, R34, R35, R36, R37, R55, R56, RL1, RL2, RL5, RL9, U01, U19, UC1, UC7

L Applicants - 5 activity codes, between 2003 and 2012, Type 1 applications, these include:

L30, L32, L40, L50, L60

K Applicants - 24 activity codes, between 1993 and 2012, Type 1, including subprojects, excluding K12, these include:

K01, K02, K04, K05, K07, K08, K11, K14, K15, K16, K17, K18, K20, K21, K22, K23, K24, K25, K26, K30, K99, KL1, KL2, KM1

DEGREE DEFINITION

Degree groupings are defined by the following combinations:

Degree Grouping	Degree combination
PhD	PhD
	PhD/other
MD	MD
	MD/other
	MD/Dentist
	MD/Dentist/other
PhD/MD	PhD/MD
	PhD/MD/Dentist
	PhD/MD/other
	PhD/MD/Veterinarian
	PhD/MD/Dentist/other
	PhD/MD/Veterinarian/other
	PhD/MD/Veterinarian/Dentist
	PhD/MD/Veterinarian/Dentist/other
Veterinarian	PhD/Veterinarian
	Veterinarian
	PhD/Veterinarian/other
	MD/Veterinarian
	PhD/Veterinarian/Dentist
	Veterinarian/Dentist/other
	MD/Veterinarian/Dentist
	MD/Veterinarian/Dentist/other
	MD/Veterinarian/other
	PhD/Veterinarian/Dentist/other
	Veterinarian/Dentist
	Veterinarian/other
Dentist	Dentist
	Dentist/other
	PhD/Dentist
	PhD/Dentist/other
Other	other
Unknown	unknown

Degree combinations consist of the following atomic degrees:

Degree Grouping	Degree Atom Codes
Dentist	DDS
Dentist	DMD
MD	BAO
MD	BCH
MD	BDS
MD	BDSC
MD	BE
MD	CHB
MD	DO
MD	MBBC
MD	MBBCH
MD	MBBCHB
MD	MBBS
MD	MBCHB
MD	MD
MD	MDCM
MD	MRCOG
MD	MSURGERY
other	APRN
other	BH
other	BVMS
other	BVSC
other	CRNP
other	DACVIM
other	DC
other	DCLINP
other	DCLINPSY
other	DDOT
other	DH
other	DNCCNM
other	DOTH
other	DPHARM
other	DPM
other	DSN
other	FAAN

Degree Grouping	Degree Atom Codes
other	JD
other	JD1
other	LLD
other	MMED
other	ND
other	OD
other	OTH
other	PHAR
other	PHARMD
other	PHM
other	PHMD
other	PHRMD
other	PSYD
other	RN
other	RNP
other	VDOT
PhD	DMEDSC
PhD	DMSC
PhD	DNS
PhD	DNSC
PhD	DPH
PhD	DPHI
PhD	DPHIL
PhD	DPHL
PhD	DRPH
PhD	DRSC
PhD	DSC
PhD	DSW
PhD	EDD
PhD	PDFELLOW
PhD	PHD
PhD	POSTDOC
PhD	POSTDOCTRA
PhD	SCD
PhD	SD
Veterinarian	DVM
Veterinarian	VMD

In the above defined degree mappings, nurse-scientists fall primarily under the PhD or Other categories. To gather data on the trends for nurse-scientists as participants in the NIH-funded workforce, the following search strategy was employed in the NIH data system: Principal Investigators (PIs) were categorized as nurse-scientists if they listed any nursing degree or credential in the following list: RN, RNP, BSN, MSN, ANP, PNP, ARNP, FNP, CRNA, DSN, CNM, DNSc, DNS, DNP, FAAN, DRNP, CAN, APRN, CNRN.

RACE/ETHNICITY DEFINITION

Race/ethnicity groupings are defined by the following categories:

Race Grouping	Race Categories
Asian	Asian
Black	African American
Hispanic	Ethnicity = Hispanic
Native	American Indian/Alaska Native and Native Hawaiian or other Pacific
White	White
Other	More than one race
Unavailable	Unknown and Withheld

GENDER DEFINITION

Gender groupings are defined by the following categories:

Gender Grouping	Gender Categories
Female	Female
Male	Male
Unknown	Unknown and Withheld

NOTES

INDIVIDUAL APPLICANT DEFINITION

In a fiscal year, an individual applicant is counted only once per IC and mechanism.

In the event an applicant applies more than once to a specific IC and mechanism, the most recent awarded application is selected.

Appendix IV: Summary of Quantitative Findings

A full set of graphs with corresponding raw data is forthcoming and will be available from the [NIH *RePORT* - WORKFORCE](#) website.

Appendix V: Qualitative Research Findings

Medical Students and Deans

Introduction and Method

On behalf of the Physician-Scientist Workforce Working Group (PSW-WG), Catalyst Research & Communications conducted two qualitative studies to explore how medical, dental, and veterinary students make decisions to pursue or not pursue a career in research. The first of these studies was a series of focus groups with students; the second consisted of interviews with research deans at medical, dental, and veterinary schools.

Focus Groups

To conduct the focus groups, Catalyst developed a moderator's guide with a standardized set of questions that responded to PSW-WG's perceived needs for information from medical, dental and veterinarian students about their career decision-making. The guide may be found at the end of this report. OMB clearance was obtained to recruit and collect qualitative data using the set of questions. Catalyst recruited a convenience sample of geographically diverse students via Facebook announcements on student medical/dental/veterinary association pages, referrals from medical deans, and email requests for participation sent out from student medical associations to members and medical/dental/veterinary schools to their students. Wherever possible, students were recruited from among those in their final year of professional training.

Nine telephone-based focus groups were conducted between December 2013 and March 2014. The groups were organized as follows:

- Two groups of MD/PhD students (11 individuals)
- Three groups of MD students (15 individuals)
- One group of underrepresented minority MD and MD/PhD students (5 individuals)
- One group of DVM students (7 individuals)
- One group of DDS students (6 individuals)
- One group of DVM/DDS/PhD students (6 individuals)
- Each focus group lasted approximately 90 minutes. Focus groups were audio- taped and transcribed for analysis.

Summary of Common Themes across All Groups

Key themes that emerged across all student focus groups include:

- Students enrolled in a dual degree program, including those who obtained a PhD before or after their MD/DVM/DDS degree, are considerably different from the general population of medical/dental/veterinarian students. Notable differences include:
 - Dual degree enrollees typically fell in love with science at an early age (often prior to high school) and speak more passionately than other students about the creativity they find in scientific research.
 - Dual degree enrollees are motivated by a desire to make a bigger contribution to society through the discovery of new diseases/treatments than they feel they could by seeing individual patients.
 - Dual degree enrollees (MD/PhD, DVM/PhD, DDS/PhD) accept that the path to becoming a physician-scientist is a long and arduous one; they are willing to make the sacrifices needed to achieve their goals.
- Students who are not enrolled in a dual degree program are usually primarily motivated to care for patients. They may have enjoyed the research experiences they've had as undergraduates or medical/dental/veterinary students, but are concerned about the length of training required to become a physician-scientist, their ability to repay student loans, and the uncertainty of research funding.
- Exposure to research as a career option played an important role in students' decisions. Minority students, in particular, noted that they were not exposed to physicians who conducted research as they were growing up.
- The majority of single degree students stated that they first became interested in research as undergraduates in college. A few stated that they really had no interest in doing research before they became exposed to research opportunities while in college. Others reported that the influence of a professor or mentor in their undergraduate years greatly influenced their decision to pursue research. In fact, some students reported that they felt they had chosen a specific career path (e.g., pursuing a basic science PhD) but research opportunities in the medical professions in college helped steer them to new opportunities. Finally, a few participants credited family members with encouraging careers in science.
- The uncertainty of research funding was the major challenge to a career in research articulated by both dual degree students and single degree students interested in pursuing a research career. By far, the largest concern from students interested in research is the issue of funding and the uncertainty of the funding. Job stability is very concerning to those who wish to pursue careers with research components.
- Having a positive experience with a mentor was often a primary influence on students' decision to pursue a research career. The importance of good mentors was stressed throughout the focus groups. Students reported that while a good mentor could really help them and guide them through their training, a poor mentor can also be helpful in teaching a student what not to do or how not to lead students. Mentors with good research funding seemed to make a better impression on students than those without solid funding. Focus group participants reported that some mentors even discouraged them from pursuing research in a lab without good funding.
- Students felt that conducting research is very time consuming and without the right support, in the form of mentorship, research is difficult. Students worried that even with a huge investment of time committed to research, they may not achieve outcomes that are useful or publishable.
- Work/life balance issues are uppermost in students' minds as they contemplate a research career, including their choice of specialties. This is true for men, as well as women. Dental students, in

particular, say that they chose dentistry because it is a high-paying profession in which they can set their own hours.

- For those less interested in pursuing research as part of their careers, the reasons cited were long work hours, negative family-life balance, research funding issues, lower pay, and the perceived inability to do research part-time and still be successful.
- Achieving the trifecta of research, teaching, and clinical care seems nearly impossible to most of these students. The need to balance life and varying parts of work is daunting and they do not seem to have many role models who they feel have successfully achieved this in all areas.
- Students pursuing an interest in research at non-research-intensive schools feel isolated and are hungry for ways to connect with a greater physician-scientist community across the network.
- Students, particularly those that are non-Medical Scientist Training Program (MSTP) programs funded by the National Institutes of Health (NIH), are woefully uninformed about NIH early career funding awards and the loan repayment program.

Summary of Common Themes and Recommendations by Group

MD/PhD Students

Students' Background and Family Circumstances

Several of the students in the MD/PhD program applied to their dual degree program as a secondary decision. They initially wanted to obtain a PhD and do scientific research, but decided that the additional MD degree would enable them to do meaningful clinical research and would add variety to their career. Others wanted to be a medical doctor first and then heard about the MD/PhD program, in which they could obtain a dual degree. The MSTP program was also an attractive incentive to fund their training. They spoke passionately about the creativity they find in scientific research and their interest in asking questions and solving problems. The MD/PhD students had a variety of research interests, e.g., bioengineering, behavioral neuroscience, HIV/infectious disease, immunology, epidemiology, electrophysiology, lipid metabolism, ophthalmology (translational research), ontology, pediatric vascular physiology, virology.

Over half of the MD/PhD students in the focus group were married or in a committed relationship. One female had a teenage child and one of the male students was expecting a child.

Past Influences on Pursuing a Career in Research

The majority of the MD/PhD students who participated in the focus groups fell in love with the process of research in high school, during summer research program, or as an undergraduate. Most were exposed at an early age to research role models/mentors, either via a high school program or in a research lab as an undergraduate.

Some of the students were motivated to do research as undergraduates and during the summer in order to be more competitive when applying to medical school, and were then drawn to a research career. The MD/PhD program was a good way to incorporate all of their scientific interests.

One student noted:

"In my situation, I was meeting people that do research that informs clinical practice in my medical training early on--that really flipped the switch and made me decide to get into the MSTP."

In terms of mentors, most students noted that a variety of mentors were important throughout their undergraduate years and medical school.

The students note that they need to be proactive about finding a research mentor. Even though mentors are assigned to MD/PhD students at some institutions, not everyone in the MD/PhD track is able to find a mentor at their own institution. It is critical to reach out and find mentors at other institutions that they may meet at conferences and other venues:

"So I would say that I have to be open to the possibility that anyone that I come across could be a mentor for some very particular part of my career. They play different roles. I have scientific mentors, work/life balance mentors, and mentors for certain areas of research that I want to go into in the future."

Most of the students agreed that early mentors in high school and undergraduate are found by chance. Later, the mentorship search *"tends to be a decentralized process."* Schools try to set students up with a mentor, but practically it becomes difficult and often depends on the size of the institution and other factors. Many mentors are found by working in a variety of labs, going to conferences, and hearing lectures by those who are doing the type of research a student interested in. All of the students mentioned utilizing the skills and expertise of many mentors during their training.

"A good mentor is able to give you the time and support to learn, but allows you to do things on your own when you are capable--and knows the difference between the two situations."

"A mentor should be focused on helping you advance your career by sending you to meetings, connect with the best quality science researchers, and sharing personal, professional connections."

"A good mentor combines the ability to be both an excellent scientist and a human with good social skills and knowledge of how to expand a career."

Current Considerations about Pursuing a Research Career

All students in the MD/PhD focus groups had many positive comments about embarking on a career as a physician-scientist. A research career is appealing for the following reasons:

"My clinical research really matters - it has direct impacts on clinical practices. I can see the people actually benefit from it. I really believe it is worth doing and it will better people's lives."

"You know...better therapeutics, better devices and instrumentation, understanding a disease better or even understanding normal processes that are not well understood because there is still a lot of that out there which I don't think most medical students even realize that is true. The more we know the more we know there is a lot more left to discover."

"I want a solid academic career and to do that, I need to do research in order to achieve academic ranking."

Thus, among the reasons are:

- Asking questions that are relevant, meaningful, and make peoples' lives better.
- Being able to do something that benefits many people, not just one patient. Being able to answer essential questions that have implications into disease pathologies.
- Serve as a bridge between the basic science professionals and the clinical professionals.

The students admired successful physician-scientists, who are able to continue getting funded for research. They admire those who have the ability to communicate in both the research world as well as the clinical world. They find it impressive that successful physician-scientist are able to maintain both excellent research skills and excellent clinical skills.

On the other hand, these students described the older physician-scientists who are running a lab, being a mentor, and an academic teacher/advisor, as looking tired.

Each student in the focus group verbalized that the uncertainty of research funding was the major challenge to a career in research. Financing a career in research and the perceived politics of government funding makes each one nervous about being able to sustain a career as a physician-scientist.

Other challenges include:

- Having protected research time, especially in non-traditional specialties.
- Finding the right balance between clinical interests and research interests.
- The time required for grant writing is a concern: *"Having to put in lots of energy toward things that can often seem peripheral to the real goal."*
- Surgical research has its own specific challenges because to be a good surgeon, one needs to keep up surgical skills. Research time is limited. It's hard to be competitive in the field when one is competing with full-time PhD scientists. It is a struggle to do well in both fields. It's sometimes hard to get a surgical residency when the individuals wants/needs to have time to do research.
- The salary inequity differences can be a challenge:

"Sometimes, we have to make up the difference in lower research pay by doing clinical work. Researchers may be financially disincentivized by the institution for them to do research."

In particular, residency is a time when there is lack of research mentorship. Students perceive this to be the most vulnerable time of research training. When a student is not engaged in research for four to six years, it may be difficult to re-establish a research career. During that time, a student won't be doing research or publishing papers. It makes it harder to be competitive for a K award and ultimately for an RO1.

The pay cap of NIH grants may make it difficult to be hired. Department chairs may think twice about hiring someone who needs 50 percent protected time for research. The department has to supplement salaries to achieve the typical physician-scientist salary.

Work/life balance in a research career is a topic that is top of mind to these students. Most are willing to put in as much time as needed while a student and in training, but perhaps may not be willing to do so

when they begin their careers. They understood from the beginning that finishing a dual degree is a long and arduous process. Work/life balance was of biggest concern when looking ahead to their post-training careers. Work/life issues are portrayed in the following student comments:

"The whole work/life balance fear increases with the decrease in research funding rates. I do have a concern that the rest of my life may suffer in a negative way that I am not sure I am completely willing to allow."

"I hear a lot of my colleagues say I want to do well but I am not going to stress myself out and I would settle for a little bit less as long as I am happy."

"I want to do well in the workplace, but I also want to be that mother to my kids. I don't want to be an absent parent." This is a stronger issue for women, but men also stressed this point.

"This is something that concerns me a lot moving forward - not being able to see many females being successful at making things work and balancing having kids with having a career."

Most females did not think it was an option to take time off for family issues. It is hard to take time off in academia or if the physician-scientists has his/her own lab. Many are afraid that it would negatively affect their promotion potential.

It may help to promote "team science"--- this may become more important, particularly with decreasing funding opportunities.

Future Plans and Influences Regarding a Research Career

When asked where they expected to be in 10 years, the MD/PhD students said they would just be finishing their residencies, and hoped to be involved in a research career that launches them into a career where they become an independent researcher. Many mentioned they would like to be in an academic setting with some clinical responsibilities.

Recommendations for Making Research More Appealing/Feasible in Medical School

Several recommendations from MD/PhD students focused on obtaining adequate funding as a student and during residency. Suggestions included:

- Promote/expand the Ruth Kirschstein F30 programs for MD/PhD programs.
- Recommend some kind of mechanism (K award) to help in transitioning between residency to becoming an academic clinician-scientist. There should be K awards for every kind of specialty.
- Have a funding mechanism for longitudinal support, i.e., smoother transitions to residency and fellowship. This is a really critical point in the career pathway where many MD/PhDs give up on research. This would ensure protected research time during residency, even in less traditional specialties. This funding mechanism should be awarded to the individual rather than the institution.
- Create a K99 specifically for MD/PhDs applying for residency.

Other recommendations focused on increasing networking avenues and better communication with NIH. Specific recommendations include:

- Students in non-MSTP-funded dual degree programs are not included in networking opportunities and often students are not aware of funding opportunities. A few suggested the need for a baseline protocol for all MD/PhD programs, whereby students participate in conferences and other networking avenues to enable them to network with experts. These non-MSTP programs may not have faculty who value research, and therefore there is a need for better mentorship. The MD and the PhD programs at these universities may not communicate well.
- A webinar series that describes the student funding mechanisms at NIH and what MD/PhD professionals can do with their careers. Many students at non-MSTP funded schools are not aware of the mechanisms.
- Travel awards for students to attend conferences for networking and access to potential mentors.
- NIH could send quarterly informational research newsletters to all universities that have MD/PhD programs.
- A mechanism for networking with experts, especially in those underrepresented areas of research, e.g., epidemiology, economics, biomedical engineering. NIH could set up an online center for those who are contemplating a career in a certain specialty to gain more information and to network with those doing research in that area.

Several students made suggestions for making their training more cohesive and relevant for the needs of research and clinical practice. These suggestions are:

- Develop guidelines for continuing the research experience during the residency years.
- Streamline training: The training for MD/PhD programs is getting longer and longer. One idea was to put all the research training into the residency to reduce the length of training. This would consolidate the research to a student's preferred specialty and eliminate the gap in research training during residency. Some trends in medical school are to decrease medical school from 4 years to 3 years.
- Address the average age of obtaining the first RO1. It has increased to 46 years of age.
- Increase the salary cap for researchers.

MD Students

Students' Backgrounds and Family Circumstances

MD students who were interested in pursuing a research career went to medical school because of their interest in science, in being able to interact with and help people, and in doing research that addresses questions of clinical care:

"I went to medical school because I wanted to do research that was clinically relevant. And I thought doing that through an MD degree would be the way to do it."

The research interests of those interested in pursuing a research career included computational biology/applied math, neurosciences, neurology, and translational research.

Those students not necessarily interested in research career went to medical school because they liked patient care; were interested in the concept of healing, health disparities, and/or teaching; and liked working with people. They would like to conduct clinical research if they could also have a clinical

practice that was over 50 percent of their work time. Their research interests were mostly along the line of their clinical specialties, such as orthopedics, anesthesiology, neonatology, oncology, etc.

The majority of the MD students were in a committed relationship or were married, but none had children.

Past Influences on Pursuing a Career in Research

All the MD students who participated in the focus groups thought that research experiences help to increase their critical thinking skills and makes them more competitive for residencies and fellowships.

Those who are interested in pursuing a research career initially became interested in research because it was required for an undergraduate degree, a professor pointed out that there were research opportunities, or they attended a summer research experiences for undergraduates (REU) program.

Many had professors during their undergraduate careers who served as mentors. These students look to mentors who have a supportive financial infrastructure, so they can learn research methods from the senior scientist and lab manager and also be allowed to have an independent project. In addition, they look to mentors for tips on work/life balance. Students mentioned that enthusiastic mentors have broad overlaps with them as far as professional and academic interests.

"And then just because a lot of time we look to these mentors as much more than just a research mentor but sort of as a guidepost for our careers, I think it was -- some of the most memorable things are when they involved me in their own social outlets. We sort of identified areas where they struck work/life balance."

For those students who were not particularly interested in a research career, they got involved in research as an undergraduate to make them more competitive in their applications to medical school and residency, especially for the more competitive residencies, such as plastic surgery, orthopedics, and radiology . Students feel like they need to check the research box to be competitive, it is a "CV booster."

"To be honest, I started to get involved with research initially for applying to medical school; it was one of the boxes that needed to be checked off. And then I got involved in simulation and medical education at school because it relates to my previous career where I was a software engineer so I had that sort of interest and was able to explore it in that direction. But I think I initially got interested mostly because I felt like it would make me a more competitive applicant more than anything else."

"I started doing research to improve my application for residencies but what I found really compelling about it was that both of the projects that I have worked on have been things that my PI was just interested in understanding a little bit more about, and so we designed a project to kind of look at it, and you now see the actual quantitative data behind things."

"I started research in undergrad, mainly to boost my application for medical school, and it was mostly basic science stuff, really. Just get your name on a paper. No true interest in anything. As I went through medical school--the common theme again--you need research to get a competitive residency, so I kind of like -- it has transitioned over a little bit. "

"But I think that it is more of just like, you know, a check box, and not a lot of students are really passionate about it. And not to say that they don't like research. I think they are just more passionate about clinic, about patient care and that realm of medicine as opposed to the behind-the-scenes aspect of it."

Some students have had good mentors. They mostly met their mentors fortuitously via summer research programs or in labs at school. In general, these MD students have had mixed luck with finding a good mentor.

Current Considerations about a Research Career

A common concern about embarking on a research career centered around the perception of not being able to have a thriving clinical practice while engaged in a research career:

"The only thing probably holding me back may be not having as much patient interaction as I would like. If patient interaction and research could go hand in hand, being a physician and physician scientist--that would be the best of both worlds."

"I would need to find a balance between being able to see my patients and fulfilling my role as a researcher. And if I could, you know, find that balance, then I would definitely do both but it is hard."

Regarding potential pay differences between those in private practice and those engaged in research, students who are very interested in building a career in research accepted that they will be making less money. They were hoping that the funding landscape will be better by the time they are applying for grants.

"I have the expectation that I would be making less money doing research compared to the private practice. I think that is something that I have accepted to be true."

"And I guess that uncertainty about the future of how funding works and the situation that the government is in now, I think that -- it makes me worry a little bit but at the same time I think it is so far away that it is not something that is in the front of my mind."

These students were concerned about clinical/research balance. When they observed physician scientists in their schools, they found these individuals were mostly doing bench research and not seeing patients. The students thought that was unacceptable for their careers. They believed that a 50/50 split is possible depending on the clinical specialty, and that would be determined when they apply for residency.

Length of training to get a PhD is also a concern. This quote is from an MD-only student with her thoughts about the length of training for an MD/PhD:

"I think in terms of the training, what concerns me about the MD/PhD is--it is not just the not wanting to be in school for that long. I have heard some criticisms of the structure of MD/PhD programs because if you are going down more of a basic science path, which I think a lot of people who do MD/PhD pursue--since the science field is changing rapidly as well, just the techniques that are being used in practice--that by the time you finish your PhD and you go

back and finish what you have left of medical school -- you know, you got out and you finished your residency. You got out and you start practicing for yourself and start to have your own lab, and the science has just changed a lot.

Work/life balance issues were also of mind for the MD students:

"I think for me too, you know, time right now is not a big deal, but I feel like, you know, planning a family and raising a family, that is definitely going to take away from the time you have to practice and any time you have to do research. It is something I would have to balance and consider." (male student)

"For me, family is a big priority so I think in terms of the specialty I would choose, I would choose a specialty that wouldn't take me away from my family too much. So I guess something like surgery, if I get stuck in a surgery and can't go home, that is not something I would really like. So I probably wouldn't want to go into surgery because of that lifestyle, and just me personally, I have wanting to raise a family as a high priority." (male student)

Students wanted to be autonomous when they get out of training. They wanted the flexibility and time to be able to enjoy a family and a life. They were looking to create a work/life balance and also love the work they do. Work/life balance played a major role in the decisions these students were making for their careers.

Most students respected and admired those who are physician-scientists, but they were not particularly interested in navigating the grant funding process. Many students pointed to the reason they went to medical school and that was to take care of patients. That is what they intend to focus on.

"And it is almost like being, to me, how artists have to go out and get gigs and do that whole thing. I feel like researchers have to like go out and find grants, find funding, find people who believe in them, and it just seems really, really tedious."

From a student who has aspirations to do research:

"I think the funding environment now is something that is pretty scary. I think, too, as somebody who has not elected the MSTP track, I am even more nervous about how much legitimacy I will have as a PI one day. But to me something that is comforting too, as someone going into academic medicine, I feel like I have got a marketable skill set in my clinical training that I can fall back on should research need to fall by the wayside if funding, you know, doesn't work out or something like that."

When asked about their observations of physician-scientists in their school, these MD students admired their incredible focus on a specialty, as well as their persistence and ability to prioritize and juggle multiple roles. They do the groundwork for the rest of medicine. Some felt that, as a whole, physician-scientists may be a bit out of touch with the clinical world because their clinical time is limited; and they have fewer social skills than what they would like to see in a clinician. They were quick to point out, that there were certainly some top-notch clinician-scientists serving as role models in their settings.

Future Plans and Influences Regarding a Research Career

For those students contemplating a career in research, the amount of training time, the perceived lower salary, and uncertain potential funding for research were the major influences on their decision to pursue a career in research.

"I don't want to sacrifice what I want to do in the field of medicine itself to be doing research either. I want to be able to choose a career in medicine, no matter how rigorous, and still have time to be doing well in that and learning in that field but also be doing my research."

School debt/loan repayment was also a big concern.

"I know that I am going to be graduating with a lot of debt, and knowing that research makes less money, I think it makes me feel a little hesitant about it just because I know if I have a lot of loans to pay off. And I know the situation is different for MD/Ph. students, but I think for MD-only students who want to become physician-scientists that having a lot of debt presents a barrier."

When feasible with medical school commitments, MD-only students with an interest in research found a mentor to work with and spent between 10-20 hours/week on research projects, mainly in a lab setting. These mentors may or may not be a part of the medical school. The student proactively sought them out and made the connection.

Funding was an issue for those MD students who would like to pursue a PhD, and are not in an MD/PhD program:

"For me, I am actually considering that right now. My school has a way for MD students to get into the MD/PhD program, so I am in the process of trying to apply for that. It has been kind of difficult for a number of reasons, and I might be in a situation where instead of going into the MSTP, I would have to take a leave of absence and do the PhD separately."

These students would like to be in academia and combining clinical practice with research. Many of the MD-only students foresaw an academic or clinical career with some research involvement for themselves, but not necessarily having their own lab or lab group.

To a person, the MD-only students were not planning or interested in seeking a PhD after medical school. They may consider an MPH or take a year out for research training. One said she would consider working towards a PhD if she could see a very specific reason why she needed it. Many felt that they could do research with their MD degree, especially if they partnered with a PhD researcher.

Recommendations for Making Research More Appealing/Feasible

The MD-only students made the following recommendations for making a research career more appealing or feasible:

- Create exposure to what a physician-scientist career looks like.

"I think in the MD/PhD program, that program provides a lot of -- whether it is like seminars or just workshops that sort of educate about what it looks like to be a physician scientist and the things you need to do now in medical school to build a career toward that. I don't think the MD students get much exposure to that. Maybe it has to be a top down thing from in the medical school curriculum or just having workshops or seminars that would educate us that a physician-scientist is something that exists, and these are the ways others have done it. I think having that information would help MD students work toward a career as a physician-scientist."

- Create a more equitable loan repayment program for MD-only students.

"So for the NIH to further promote research, I think having grants available to junior faculty members or more to fellows, that would encourage people or would allow people to take time early in their career, a little bit of time away from their clinical practice, in order to supplement their income so they are able to do research."

- Offer a fast track research or fast track residency option to MD-only students with interest in research.

"I know that MD/PhD students are sort of educated about fast-track research or fast-track residency options where effectively your residency is shortened because of the assumption that you will engage in research in your future. And I don't honestly know if that is even offered to people who may not have completed a PhD but still have significant research experience. I think it could really expand the number of physicians interested in research if their residency was also equipped with some benefits or a fast-track option as well."

- Create programs with continuing medical education (CME) credits for basic science, such as methodology training.

"And to my knowledge there are not CME credits available for basic science, like methodology training. And as somebody who is interested in basic science training, like my greatest fear is that I will forever be inadequately equipped to handle changes in science, especially if it only occupies a fraction of my work."

- Continue to fund Summer Research and Diversity Programs.

"They should continue to focus on funding the Summer Research Programs and the Summer Diversity Programs, that bring students from multicultural backgrounds into labs, research labs and medical schools in the summer to do research because the program that I was involved with, it was NIH-funded. And also continue to offer research summer fellowships during medical school for medical students because most of the time we can, if we do research at our medical school, we can get funded by internal grants. But when we go outside of our medical school, it is a little bit harder to find funding."

"There is a program called the Summer Medical and Dental Education Program that I participated in as an undergrad that targets underrepresented minority students to prepare them for medical school. And I think that is a program

through the AAMC [Association of American Medical Colleges] that the NIH should target. Also implement a research component to that program.”

- Fully embrace pre-med and MD-only students in Science, Technology and Mathematics (STEM) programs and summer program application processes:

“And what I found is that it is really hard to find a program -- like if you say you are pre-med, a lot of STEM programs, they like look down, like don't want you to apply if you are trying to do pre-med. Like they want you to go strictly into a PhD or MD/PhD program. Like I found a lot of programs that were like that and very few that were looking for pre-meds.”

- Consider a program that provides mentors for underrepresented minorities in research, beginning at the high school level.

“I think that having mentors and having role models that are from underrepresented minority groups really inspires a lot of the minority students to know that they can achieve something. They can achieve and should aspire to achieve a career in research or a career in medicine. I know that, and for me personally that was a big driving factor to work hard to, you know, work hard through undergrad, through medical school, knowing that I can achieve what they achieved. And also having them available, having them on the faculty or as mentors for undergraduates and for medical students I think would be another way to increase the number of minority students in medicine and in research.”

- Encourage incorporation of research training in medical schools, to take advantage of the trend to condense the pre-clinical years of medical school. Students could become more involved in research during this flex time:

“So having the NIH encouraging kind of a physician research pathway -- whether it is basic science, public health, clinical research -- in medical schools, and encouraging medical schools to have a set curriculum with mentors in place, with lectures, physician panels in place, for example, would be I think very helpful for doing the first and second years of medical school.”

- Provide information to communicate research opportunity and loan reimbursement mechanisms to MD-only programs:

“I think that there are programs out there that I have been lucky enough to hear a little bit about, but I am not sure their overall exposure to people in our shoes is that fantastic.”

“I would really love to have some information on how to write grants and where to apply for them and how that all works. So I think that would definitely be something I would be interested in.”

“I think honestly having this information more advertised at individual schools, because to be honest I hadn't heard of anything moneywise that has been talked about in the last two minutes.”

Minority MD and MD/PhD Students

Students' Background and Family Circumstances

Minority MD and MD/PhD students all expressed an interest in careers focusing on health care in underserved areas, public health, health policy, and health disparities. They were aware of the National Health Service Corps (NHSC) payback programs for working in medically underserved areas of the country.

Those interested in doing research would like to combine clinical or academic medicine with research. Hopefully a 50/50 split: *"I need to find the right balance of the two."*

The majority of these students were single, without children.

Past Influences on Pursuing a Career in Research

Research mentors have had a big influence on these students as undergraduates and medical students.

The consensus of the group was that many do research in medical school to make themselves more competitive for hard to get specialties or residencies at institutions that have a strong academic and research base: *"People who apply in more competitive specialties take a year out to do some research and to get a couple publications or abstracts that help improve your resume."*

Minority students wanted more exposure to minority role models in the sciences, medicine, and research. These students reported that they needed to see the possibilities of a research career early in life, e.g., in elementary or middle school, so they can start in the science track. Most reported growing up seeing physicians provide patient care only. In addition to this exposure, there needs to be opportunity.

There was a perception among the minority MD and MD/PhD students that there isn't a lack of minorities in medicine, but there is a lack of minority role models in research.

"But definitely when I got to the research aspect, and I got in a lab, I did notice kind of a disparity. I definitely saw more Caucasian and Asian physicians participating in research whereas the community physicians that I saw working at some of the clinics that were on sliding-fee scales and in the underserved minority communities--I did see a lot more ethnic diversity there."

Current Considerations about a Research Career

The minority MD and MD/PhD students who participated in the focus groups felt that at this point in their careers they don't have to worry about getting funded, but they have observed their research mentors and heard about the dire funding situation and how hard it is for young PIs start out.

"I personally don't have a really good sense of what it is like to be a PI. I sort of see what my PI did. He was a more senior person, but sort of also overseeing the more junior people. They spend a lot of time worrying about their funding situation and whether or not it is going to be there, the next funding cycle...if it is going to be renewed."

The amount of time needed to pursue a career in research was not appealing to these students, particularly

in light of the importance they placed on work/life balance:

“You see PIs, especially young PIs, regularly working 80-hour weeks. Even in fellowships I have seen people working 60, 80 hours, like nonstop, while trying to have a family. And it just looks difficult and draining and tiring.”

The uncertainty of finding positive answers to research questions was also daunting to students.

“And if you don’t really love it, then I can see you getting burned out very, very quickly. And that is kind of scary to me. I think the other aspect is that as much as you want -- I think you have to enjoy the journey more than anything else. I think some people really like research and they don’t mind failing and they don’t mind getting answers that are wrong -- well, not wrong, but that go nowhere.”

“It is important that you enjoy the pursuit of that answer. And I think for me, I don’t, I would rather -- I would be very upset if I chased something for 10 or 15 years and found nothing at the end of it.”

Another concern was the perception that there are not a lot minority physician-scientist role models in research:

“I think a concern for me about going into a research career, what would be scary for me, with me being an African-American woman, a black female, and I mean facing the facts of things -- I have done research before, and I feel like, you know, you see a lot of either white males or you see a lot of Asian males.”

“I have been the only person, black person in biology class since I was 14.”

Future Plans and Influences Regarding a Research Career

Most minority medical students saw themselves 10 years from now in clinical medicine careers with research as a smaller percentage of their time. They also would like to be affiliated with an academic medical institution.

Lifestyle and work balance was quite important to minority medical students. They believed the length of training eats into family life and recreation. They want to enjoy a family:

“I think it is really important consideration because, you know, if you are doing something and that is all you can do, you can’t do anything else, you can’t see your family, you can get kind of miserable.”

The amount of loans they need to pay back also played a big role in their assessment of how quickly they are able to get out and practice and make a good salary.

Recommendations for Making Research More Appealing/Feasible

MD and MD/PhD students from underrepresented minority groups made the following recommendations for making a research career more appealing and/or feasible:

- Create a viable pipeline for promising minority students in science to become minority physician-scientists. There are some minority programs, but there aren't enough of them and they don't tend to follow through in the sciences and research.

“And by senior year I would say 75 percent [of my minority classmates in undergraduate school] were done and they had gone to more of a sociological or humanities-focused majors because that is where, at this point, a lot of minorities tend to flock to just because there are no minorities in science. And I think that is frustrating. People tend to go where they see people who look like them.”

“I think it all starts very young because I think better STEM education has to begin way, way early to even like consider how to build that pipeline. I think a lot of times we have done a disservice to very young children who just don't have a chance later on.”

- Provide more information to students about what a physician-scientist career look like and what is the typical salary.

DDS Students

Lifestyle seems to be an important factor in choosing to pursue a DDS degree. The DDS students who participated in the focus groups really wanted to be able to set their own schedules and be their own bosses. How this plays into a career that includes research was not totally clear to the students. Still, one student clearly felt that the time commitment to get a PhD on top of a DDS degree would detract from her ability to have a family and stabilize a career.

Students' Background and Family Circumstances

Dental students who participated in the focus group offered several different reasons for attending dental school. Most reported attending school in order to provide patient care and because they liked the idea of owning their own business. One student reported that there were many dentists in her family and that helped her choose dentistry as a career. No dental students reported attending dental school with a goal of doing research.

Most DDS students mentioned that their student loan debt is high.

These students were primarily in committed relationships or married, but there were several who were single. None of the participants had children. The vast majority of participants were female.

Past Influences on Pursuing a Career in Research

DDS students reported a variety of reasons for being interested in research. Some were exposed as undergraduates. Others had research interests early on, but when they began to hone in on their true interest figured out that it was not for them and ended up going to dental school. One student reported doing research as a way to help strengthen her application to dental school. However, she ended up enjoying her experience. According to focus group participants, DDS students who are interested in pursuing a residency following graduation have an added incentive to do research. Research is a good thing to help their residency applications.

Current Considerations about a Research Career

Even those students who professed an interest in research were unsure how to be good researchers as well as good dentists. DDS students felt that in order to do a good job as a researcher one needed to devote a large proportion of time to research, and that is not why most of them went to dental school.

Dental students reported that they want to be more autonomous in their employment situations. They were not interested in working in a hierarchy of people. They wanted to be their own bosses and set their own schedules. Research doesn't lend itself to that as nicely as private practice does.

DDS students were similar to veterinary students (see below) in that they admire the clinician-scientists they see at school. They were impressed with how they are able to balance their time and how dedicated they are to their careers. However, they do not admire their lifestyles. And, like veterinary students, DDS students felt that dentist-scientists may have lost touch with the bigger picture in dentistry and don't think they are the best teachers.

Future Plans and Influences Regarding a Research Career

DDS students in the focus group wished that they had more information about careers in research, especially during dental school. Students reported not knowing about NIH opportunities as they relate to dental training and that there isn't much exposure to research as part of their schooling. One student said that she wished she had known that a DDS/PhD was an option if the PhD portion of her schooling would have likely been paid for. Students were familiar with loan repayment from the military, but they didn't know about other training grant opportunities in dentistry.

DDS students were interested in learning from each other and wanted to find colleagues that are like them. They were particularly open to networking with other students who are interested in research and having people to bounce ideas off of.

The DDS students in the focus group were not interested in pursuing a PhD following their DDS degree. A PhD for science other than bench science seemed unnecessary to these students. They all felt that the time needed to complete such a program was a major drawback. One student felt that it would be very difficult to earn money and stabilize her career prior to having a family if her training took that long. Students do see the value in the PhD degree and understand that it may be a necessity, depending on the career they are choosing (e.g., academic dean).

Two of the students in the focus group hoped to become part-time professors and part-time clinicians in the future, but the remaining participants saw themselves in private practice. They chose private practice primarily for the lifestyle it will afford them.

Recommendations for Making Research More Appealing/Feasible

- Provide networking opportunities and better knowledge of NIH opportunities as they relate to dentistry. Webinars, listservs, and conferences were mentioned as vehicles for learning more about NIH opportunities.
- Provide early exposure to research programs. DDS students need to be educated on funding opportunities for school/training at an early point; ideally, even before dental school.
- Educate students on loan repayment options that are currently available.
- Provide more networking and travel funds

DVM Students

DVM students want more collaboration between them and medical students.

Students' Background and Family Circumstances

Veterinary students participating in a focus group chose to attend school for a variety of reasons. Some went to school with the goal of being practitioners, both large and small animal. Some reported very targeted goals, such as working with seeing-eye dogs or lab animal medicine. One student reported having an interest in research and said that was her real reason for getting her DVM degree.

These students reported a variety of family situations. The majority of students we spoke with are either married or in a committed relationship. No participants reported having children. The vast majority of participants were female.

Past Influences on Pursuing a Career in Research

Veterinary students in the focus group generally admitted to not really being interested in a research career at all. Some said that their undergraduate experiences helped shape their research interests.

One veterinary student said that she decided to pursue a DVM because her mentor made her feel like she might not be smart enough or able to pursue a research career. Several students credited their first mentors to really guiding them and helping them choose what further education to pursue.

Current Considerations about a Research Career

Veterinary students, while passionate about the care of animals, did not have as positive of an outlook on careers in research. The majority of DVM students wanted to practice clinical medicine. They were not research driven. They felt that veterinary schools were best equipped to prepare them for clinical jobs. Also, they noted that NIH does not have a center dedicated to veterinary science.

These veterinary students would like other professionals to better acknowledge the value of a DVM degree. They thought the DVM degree should be a viable degree to do research, and don't feel the need for a PhD to do research. A PhD for science other than bench science seems unnecessary. Instead, DVM

students would like to see more research done by folks who are primarily clinicians. They believed that research can be incorporated into clinical practice settings.

At the same time, some felt that the time commitment of research would be very intimidating, hence raising work/life balance concerns. They felt that their DVM degree might appear to be insufficient in the research world and the time it would take to get a PhD in addition to their DVM was daunting. In terms of balancing research and clinical, most felt that after learning how to balance school and family they would be able to manage their time upon graduation.

A concern about paying off student loans was also raised. Participants wanted to graduate and start practicing medicine in an effort to start paying off their debt. Further studies would only increase the debt and time to pay it back. For those DVM students that wanted to pursue an internship or residency, that means more years of low pay. Lost wages were an issue for these DVM students.

Still, DVM students tended to admire clinician-scientists in their field. They were consistently impressed with their ability to stay current in their field and use their intelligence to problem solve. However, they reported that not all clinician-scientists were good teachers. Students see their clinician-scientist role models as being “out of touch” or lacking certain social/teaching skills. They also observed that clinician-scientists have to deal with a lot of politics related to the university setting as well as communication issues. These factors may be a deterrent to becoming a clinician-scientist.

In an ideal world, DVM students would like to see that their degree has value in the research world. Students were not sure why they need a PhD to do research or if that is just a perception. Veterinary students wanted hands-on experience – that is why they went to school in the first place. The need to find a way to balance that with research would help DVMS in their effort to pursue research as part of their career.

Future Plans and Influences Regarding a Research Career

Most of the veterinary students in the focus groups were on a clinical career path. Only one was committed to further schooling and the idea of a future PhD. She would still like to have a clinical career but is worried about the long time it is going to take to achieve her goals. Other students saw themselves teaching at universities or furthering their training to align their education with their specific career goals. For example, there was one student hoping to be a rural food animal veterinarian in a farming community. She wants to help the farmers in addition to the animals and noted that there is no direct career path for making that happen – she will have to find her way. Another student who was interested in sled dogs and wildlife research also noted that there is no direct way to get to her end goal. She was just figuring it out as she goes.

Veterinary students wanted to see more research being done by veterinary clinicians. They felt that their day-to-day experiences are valuable and could be incorporated into larger research projects. This would aid in integrating research and clinical practice.

Students would also like to see more avenues to work with medical students. There is a direct relationship between human medicine and animal medicine research, but little is taught to either group about the concept.

The concern over funding and loan repayment was brought up again in relation to career planning. DVM students would like to see more funding available for DVMs and some felt that there isn't enough respect for the degree on its own. Student loans are massive in comparison to salaries in the field and that is a large issue for new graduates.

Recommendations for Making a Research Career More Appealing/Feasible

Veterinary students made the following recommendations to help make a research career more appealing or feasible:

- Provide information about opportunities in research and employment in one place. Ideally there would be a database that had research opportunities including the funding levels and then they could find out if a clinical position was available in the same location. This would make pursuing research and clinical together easier.
- Promote the value of a DVM degree. Veterinary students seemed frustrated that research entities see a need for those holding a DVM degree to still obtain a PhD. If a PhD is necessary, one participant suggested being able to work on a PhD while employed at a pharmaceutical company, for example. This would be a way to collect a salary while still working on education. Other ideas related to this frustration were the ability to get some type of accelerated PhD.
- Provide early exposure to research careers so veterinary students begin to understand the possibilities and career pathways.

DDS/PhD and DVM/PhD Students

The DDS/PhD and DVM/PhD students participating in the focus group research were truly committed to their passions and determined to achieve their end goals regardless of the path they need to take to get there. They were not deterred by the amount of time it will take them to complete all their training. With that said, they were very concerned about debt and the ability to achieve the trifecta of research, teaching, and clinical care. Some were worried that they will need to spend a large proportion of their time writing grants and that this will take away from their time to do other things.

Students' Backgrounds and Family Circumstances

The DVM/PhD students unanimously reported that they had always wanted to be veterinarians. However, they were each interested in different types of research, ranging from retrovirology to food production. The DDS/PhD student participant originally wanted to attend school to become a veterinarian. However, she chose to go to dental school and is now interested in public health dental research.

More than half of the combined degree students in this group were currently single. One participant, who was married, had a young child. Again, the vast majority of participants were female.

Past Influences on Pursuing a Career in Research

Students pursuing combined degree programs (DVM/PhD or DDS/PhD) seemed to become interested in research earlier on in their education than those pursuing only a DVM or DDS. Several of these participants reported that their interest in research was piqued in high school. Others stated that they met a mentor early on in their research careers that was helpful in guiding them in their education choices.

The combined degree students really emphasized the need for good mentors.

Current Considerations about a Research Career

The appeal of a research career was clear amongst all DVM/PhD and DDS/PhD students. They were passionate about research and love the challenges associated with performing research. They all reported the appeal of problem solving and passion for their chosen research area. Also, the idea that one can truly make an impact in a specific field was a driving factor for some students pursuing research.

Most students indicated that the length of training is very long and makes it difficult to have a family life.

“It really is hard to just try and have a family life, try and have children, try and have a husband. Like any of that is just hard because at least the way I do research, you spend a crazy amount of hours in the lab. And when you are not in the lab you are researching and you are thinking.”

“I would just comment that the process is, along with being poor for a very long time, the process is just really long and, I mean, I am sure there are some careers like, you know, becoming president or other things that take longer but, you know, I am not aware of too many other careers that take as long as it is going to take us. “

One student in a combined DDS/PhD program felt that dental schools try to engage students in NIH opportunities and help them find career opportunities. She has gotten quite a bit of support from her dental school. She feels it is because of the National Institute of Dental and Cranial Research (NIDCR), which provides research information to students. There is not an Institute at NIH that focuses on veterinary research.

The DVM/PhD students believed there was little to no support or guidance for someone looking to pursue a research career, even though they are close to graduating with a combined clinical/research degree. The prevailing feeling was that veterinary schools were not equipped to help graduates move on to a research career after finishing a combined DVM/PhD. There was concern about the transition from research during school to a true research position. In addition, even though there is a big push at veterinary schools to go into research, there is a perception that there are not many opportunities in veterinary research.

Future Plans and Influences Regarding a Research Career

The students in the DVM or DDS/PhD focus group had a variety of ideas of where they will be in the next decade. Some hoped to be in academia doing research. They understood the importance of a good mentor and would like to be that person for others. One student was sure that she did not want to be in academia and instead would like to work in industry while continuing some clinical work on the side. Students were concerned with the ability to teach, see patients, and do research. One felt that it might be easier to pursue one thing at a time instead of trying to achieve what might be impossible.

Combined degree students had big concerns about their loans. They pointed out that while some MD/PhD programs may have full coverage for tuition, this is not the case for DDS/PhD and DVM/PhD programs. As a result, combined degree students in these fields are graduating with high debt. Some students were not aware that loan repayment programs were available. They believed that the NIH loan repayment options do not really apply to their fields (the specific example was veterinary medicine) and that makes it hard to achieve the trifecta of teaching, research, and clinical care. The fact that the NIH has little money to help pay back loans is a major deterrent to becoming a clinician-scientist for these students.

Recommendations for Making Research More Appealing/Feasible

Students in the DDS or DVM/PhD focus group recommended:

- Increase the length of time that a student can have NIH training support (T32/F30). Currently the funding is only for 6 years and it is nearly impossible to complete a combined degree program in 6 years.
- Provide more training and K awards for veterinarians.

Moderator Guide

Medical/Dental/Veterinary Students with Research Interest

We're exploring how students like you--those who may be considering a career in research--think about their career decisions. The aggregate findings will be used to inform the deliberations of the Physician Scientist Workforce Committee at the National Institutes of Health about how to improve and support a sustainable and diverse physician-scientist workforce.

This focus group will last about 1½ hours.

A few ground rules for today's discussion:

1. Please just use your first name in your introduction and discussion.
2. We want you to do the talking and we would like everyone to participate. I may call on you if I haven't heard from you in a while.
3. There are no right or wrong answers. Every person's experiences and opinions are important. Please speak up whether you agree or disagree with what's being said.
4. What is said in this conversation is private to the extent allowed by law. That is, no one person's contributions in the focus group will be identified to the Committee, and we will not provide any information from the focus group to your school. Instead, the Committee will be provided with aggregated information to help them in their deliberations. We want you to feel comfortable sharing when sensitive issues come up.
5. We will be tape recording the group because we want to capture everything you have to say. You will not be identified by name in the report so all comments will be anonymous. The tape recordings and transcripts will be stored in a locked file cabinet until June 30, 2014 and then they will be destroyed. If anyone objects to being taped, now is the time to remove yourself from the group.

Any questions before we get started?

Public reporting burden for this collection of information is estimated to average 90 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. **An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.** Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0648). Do not return the completed form to this address.

Then let's begin. First, let's go around and briefly introduce ourselves. Can you share with us four pieces of information?:

1. Your first name
2. Your current family situation: single, married or in a committed relationship, parent (how many children and their ages)?
3. Your primary reason for attending medical/dental/veterinary school.
4. Your primary area of research interest (if you know)

Past Influences

5. What were the most important factors that made you think about pursuing a career in research? (PROBE FOR: Exposure to research – family member/friend in research, Mentor, Internship/summer fellowship program, college major; college vs. university setting)
6. Approximately when in your academic career did you make the decision that research might be a good career choice for you? (PROBE FOR: approximate time if they tie the decision to an event.)
7. Have you ever had a mentor/role model in research? If so, who? How did you find your mentor?

Current Considerations

8. What appeals to you about a research career? What concerns you? (PROBE FOR: How important is length of preparation, cost, potential income, lifestyle?)
9. When you observe physician-scientists around you at school or in the workplace, what do you admire about them? What turns you off? (PROBE: How much would you like your career to emulate theirs? What, if anything, would you choose to do differently?)
10. What opportunities really interest you right now? Why?
11. What would make it easier for you to pursue a research career?
12. Are you currently involved in basic science research? If so, how did you get involved? How much exposure do you have to research as part of your current schooling (coursework, etc.)?
13. FOR NON-PHD CANDIDATES ONLY: Would you consider an additional advanced degree (in science)? Why or why not?

Future

14. Where do you see yourself in 10 years? 20 years?
15. What factors do you see most influencing your career track? (PROBE FOR: length of preparation, cost, debt repayment, potential income, lifestyle)

Thank you very much!

Research Dean Interviews

Catalyst Research & Communications conducted telephone interviews with deans at 12 medical schools, 2 dental schools, and 1 veterinary school between December 2013 to February 2014. With two exceptions, the interviews were conducted with the dean of the school; the two exceptions were with a dean of education at the medical school and a director of an MSTP program.

The medical schools were selected randomly from among constituent members of the Association of American Medical Colleges. PSW Committee member Vivian Lee, M. D. , sent an introductory email to the deans of the selected schools. Catalyst staff followed up with an email invitation to participate in an interview. Twelve of the 20 deans contacted agreed to be interviewed, yielding a 60 percent response rate among medical school deans. The dental school deans were nominated by the DDS Subcommittee and one veterinary school was selected among schools that offer a DVM/PhD degree. A 100 percent response rate was achieved among the deans of the non-MD schools.

For this research, Catalyst used an interview guide for key informant interviews that was approved by OMB. The interview guide may be found at the end of this report. Each interview lasted approximately 30 minutes.

Key Findings

Key findings from the interviews include:

- Deans estimated that anywhere from 2 percent to 37 percent of their students were interested in pursuing a career in research. That percentage was smallest among dental school deans, including the school that is regarded as the “powerhouse” in producing dentist-scientists. Many deans set the general level of interest at about 10-15 percent.
- Although some deans indicated that female students were more concerned about the impact that a medical career and/or career as a physician-scientist might have on raising a family, most deans indicated that there were few differences between men and women in their interest in pursuing a career as a physician-scientist. A few with MD/PhD programs noted that there were more men than women enrolled in their programs.
- Opinion was divided about whether today’s medical students are different from their Boomer predecessors in terms of their inclination toward pursuing a research career. Several deans said no. Others suggested that students today are: 1) more technologically-inclined; 2) less willing to work hard; 3) more concerned about the stability of research funding; and/or 4) less able to devote sustained attention to a topic because they are used to earning quick reward for a quick effort.
- Deans identified the most important factors that they believe influence students’ career decisions. The stability of research funding and ability to sustain a career as a physician-scientist was frequently mentioned as an important factor, since students are observing their professors losing research funding and complaining bitterly about it. Less competitive salaries in research compared to clinical work was also cited. The factors that were considered most important in promoting interest in a research career was exposure to research, both in medical school and earlier, as well as students’ positive experience with a research mentor. As one pointed out, becoming a physician-scientist is a socialization process and the importance of good mentoring in creating a positive experience cannot be overlooked.

Recommendations for Strengthening the Physician-Scientist Pipeline

When asked what suggestions they would make to the PSW-WG, a number of ideas were put forth to strengthen the physician-scientist pipeline. A sampling of these:

- A critical juncture of an MD/PhD student is when he or she is getting out of his/her residency fellowship. At this juncture, students need gateway funding and mentoring. Gateway funding in the form of increased KO8 and K23 funding to support them as they get their first independent faculty position is key. If they go into private practice clinical work, they are lost to research.
- The NIH should provide current information on the success rate of the K awards. How likely are students to get a K award? How likely are students who got a K award to go on to get an RO1?
- Change the eligibility requirements for the Clinical and Translational Science Awards (CTSA) program that funds medical students so they can earn a Master's in Clinical Research.
- Support is needed as much in the post-doc phase/junior faculty position as any place else. When dollars are short, the return on investment is highest if we can say to candidates: if you finish your training and get a faculty position, we'll call you Scholars in (Scientific Domain).
- Both DDS/PhD and DVM/PhD programs need MSTP funding. Veterinary students need to be eligible for loan repayment programs.
- Increase high quality mentoring programs. Develop ways to share best practices in mentoring students.
- The biggest challenge is early on--instilling scientific curiosity in kids so that they love science.
- The biggest problem is how to deal with cost sharing. People don't want to lower their salaries just to do research. There is pressure from the department chair and the university to make money, which is what make so many physician-scientists drop out of one or the other. There has to be an institution-wide program with a home and with support.
- NIH could create a Physician-Scientist Student Supplement... or junior faculty supplement to a grant. Basically, a PI would take on a student or junior trainee in his/her lab and groom that student. What's most important is the actual mentorship. It can't be just an individual sitting across the desk. Mentoring can be the environment and the individual or several individuals. This would require a long-term commitment, not a one-off exposure. The success of the PI's subsequent supplement would be based on the success of his or her students. This would have an interest in mentoring students long-term.

Key Informant Guide Research Dean

Thank you for making time to talk to me today. As you know, we are conducting research to help inform the deliberations of the Physician-Scientist Workforce Committee at the National Institutes of Health about how to strengthen the nation's physician-scientist workforce. In particular, we're exploring how young people make the decision to pursue a career in research. We are talking with other deans, like yourself, as well as conducting focus groups with students.

What is said in this conversation will remain private to the extent allowed by law. That is, no one person's contributions will be identified to the Committee. Instead, the Committee will be provided with aggregated information to help them in their deliberations. We would like to tape record the interview so that we can be sure our notes are accurate. The tape recordings and transcripts will be stored in a locked file cabinet until June 30, 2014 and then they will be destroyed. Is it okay with you if we tape this conversation?

Do you have any questions before we get started?

1. About what percentage of your medical/dental/veterinary students are interested in a career in research, i. e., as physician-scientists?
2. When do most students who choose to become physician-scientists make the decision to pursue a research career? (PROBE FOR: Are their minds already made up when they enter medical school?)
3. What are the factors that most influence students' decision-making about a medical research career as a physician-scientist? (PROBE FOR: Time commitment, cost, future earnings, faculty role models who are pursuing research [e. g. , do large numbers of faculty members have NIH or other grants?] other?)
4. What kind of differences, if any, have you observed between male and female students in their decision-making about a medical research career as a physician-scientist?
5. What activities, if any, does your medical school provide to encourage promising students to pursue a research career? (PROBE for: Research track? Formal mentoring program? Preceptor programs? Internships? Technological approach? If programs exist, please describe them.)

Public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. **An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.** Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0648). Do not return the completed form to this address.

1. How do you define success in the research-focused classes or activities that you described? What factors contribute to their success or lack thereof?
2. How are today's students different from those of 20 years ago, in an inclination toward a research career? If so, what is the difference? How would you describe today's students?
3. We want to go directly to the source and ask medical school students about their decision process regarding becoming a physician-scientist, and we could really use your help. Would you be willing to help us make contact with students from your institution for an exploratory focus group about this? (PROBE: Nominate specific students? Share student contact information? Refer to student organization?)
4. What kinds of things would you suggest to the Physician-Scientist Workforce Committee that would help strengthen the physician-scientist workforce?

Thank you very much!

K Awardees

Introduction and Method

On behalf of the Physician-Scientist Workforce Working Group (PSW-WG), Catalyst Research & Communications conducted qualitative research with early career physician-scientists with mentored K awards to explore how they think about a career in research. The original plan for this research was to conduct a series of telephone-based focus groups. One focus group was conducted; however, it became too difficult to recruit enough young faculty with K awards into groups because of conflicting schedules and the 90-minute focus group format. Therefore, the methodology shifted to 30-minute individual telephone-based key informant interviews. This worked better as the interviews could be scheduled when it was convenient for each individual. OMB clearance was obtained to recruit and collect qualitative data either via a focus group or key informant interviews, using a standard set of questions. The approved instrument appears at the end of this report.

A list of MD, DDS, and DVM researchers with K awards from the National Institutes of Health (NIH) was provided by another NIH contractor for recruitment purposes. Catalyst originally planned to take a random sample of current K awardees, but this list was not up-to-date and had many errors. Therefore, names of K awardees were obtained from a search of the Internet, including specific NIH Institute sites and/or university sites, as well as by referral from members of the Physician-Scientist Workforce Working Group. This resulted in a convenience sample for the study.

One telephone-based focus group of four (4) MD/PhD K awardees (one K23 and three K08 awards) was conducted in February 2014. The focus group lasted approximately 90 minutes. The focus group was audio-taped and transcribed.

During February, March and April 2014, 13 key informant interviews were completed with physician-scientists and clinician-scientists with K awards.

Between the focus group and key informant interviews, 17 physician-scientists and clinician-scientists with K awards were interviewed. The breakdown is as follows:

- Three MD and four MD/PhD scientists with K08 awards
- Three MD and two MD/PhD scientists with K23 awards
- Two DVM/PhD scientists with K01 awards
- Three RN/PhD scientists with K23 awards

Although Catalyst contacted individuals from a list of young dentist-scientists with K awards, we were not successful in recruiting any dentist-scientists to the study.

In keeping with the definition adopted by the PSW-WG, the term “physician-scientist” is used in this report to refer to scientists with professional degrees, who have training in clinical care, and who are engaged in independent biomedical research. Those who engage in this type of research could include individuals with an MD, DO, DDS, DVM/VMD, or nurses with research doctoral degrees who devote the majority of their time to biomedical research.

Summary of Common Themes Across All Groups

Across the board, each K awardee interviewed for this study desired to spend that the majority of his/her career as a physician-scientist. Not one was interested in pursuing a dedicated career in clinical practice; among this group, only the nurse-scientists had spent a significant portion of time solely in clinical practice, and they had done so at an earlier point in their careers. These early career investigators were frustrated, however, with the precarious funding situation for physician-scientists and were resigned to the fact that they may end up pursuing a career as a clinician if they are not successful in procuring adequate grant funding.

Since K awards are mentored research awards by definition, mentors were very important to these physician-scientists. Mentors were defined in the K award proposal and are valuable assets to the K awardees. Most of those interviewed reported that they had protected research time. In some institutions, some physician-scientists were asked to take on a greater share of clinical duties and that could be problematic for the individual.

The physician-scientist track for those with a medical degree (MD, MD/PhD) was seemingly more competitive and less collegial than for those in other segments of the workforce (DVM, RN/PhD). While team science was preferred by all, the physician-scientists felt that the academic medicine culture was not in tune with team science. Physician-scientists understood they needed to publish first-author papers to be successful in competing for R01 awards and were less willing to share their data with others.

The physician-scientists interviewed for this study expressed anxiety about being under multiple running clocks during their K award years. Within the timeframe of the K award (3-5 years), they need to successfully conduct the proposed research, collect and analyze the data, publish as many papers as possible, and write a successful R award application. Competing work demands, such as clinical, teaching, and other responsibilities, can erode into protected research time.

Most physician-scientists with K awards were in the stage of life where they were married, with small children. Work/life balance issues were quite pressing, particularly for the MD/PhD scientists who are in very competitive institutions.

Three-year K awards made it very difficult to finish data collection and publish in time to put in a proposal for an R award. Five-year awards gave them more time to finish their research and amass needed publications to be competitive for an R award.

Because physician-scientists with a medical degree and veterinarian-scientists were notably different from nurse-scientists in terms of age and career history, the following analysis discusses these two groups separately.

Physician-Scientists with a Medical Degree and Veterinarian-Scientists

Past Influences on Pursuing a Career in Research

Physician-scientists in this study reported that they became interested in research early in life, most often before high school and college. The challenge and fascination with science and discovery is what motivates them to continue in the research arena. They talked about wanting to find out something unknown and apply it in practice. Physician-scientists want to do research that is relevant to human health and disease; DVM/PhD scientists expressed a desire to do research relating to the human-animal bond.

Current Considerations about a Research Career

Each physician-scientist interviewed had mentors for the K award and were happy with their assigned mentors, but most found additional mentors that they need for success, identifying these other mentors at work, during scientific meetings, or by referral.

Most expressed fear and frustration about the possibility of not being able to continue their research careers if they are not able to secure an R award. They expressed the fear that they have invested so much of their adult life preparing to do scientific research and it could all be ended by not being successful with an R award. They have sacrificed both a lucrative clinical salary, as well as precious time in the hopes of being able to continue to build a research career.

Although most stated that on paper they have 75 percent or more protected research time, in reality many other things erode into that time, including clinical service time, academic responsibilities, teaching residents, and mentoring journal club. If they have a KO8 award, there may be patient-oriented research built in, such as bench-to-bedside research elements. Even with a KO8 award, there are often clinical responsibilities.

Balance at work becomes more of an issue as time goes on. Clinical responsibilities never shrink and most likely increase. Research time tends to increase as time goes forward. One needs to write more grant proposals and write more papers to support applications. And the extra duties, such as teaching, mentoring, and presenting at conferences, tend to increase over time.

Since most K awardees are at an age where they are starting families or already have young families, the stresses of life start to increase at about the same time when the stresses of work and research are increasing. Men and women both reported this. Women, in particular have more of a difficult time because they reported having to make time for obstetric appointments, maternity leave, and childcare, which does not fit in well with a hectic research career. Supportive spouses are crucial to help with the work/life balance. The men in the focus groups did not report having major child care chores, other than their interest to be home in the evening early enough to have dinner with their family and help with bedtime childcare.

One woman reported:

"If NIH could give us some information on their feelings and whether we should be open about these things in light of women leaving research. 'Tips for young parents facing NIH challenges' would be helpful! In my initial K23 application-

- we draft our own letters of recommendation and then the mentors edit them. Mine said look at all she has done while having 3 kids in 4 years. My recommenders took ALL that out of my letters. It didn't make me 'special. ' There is then tension between having a slower trajectory because of maternity leave, but not wanting to admit that you have these pressures. "

Another frustration for younger physician-scientists is equity in pay. Salaries for physicians who are primarily clinicians are often twice or more what a physician-scientist makes.

Most physician-scientists at this stage are attempting to procure grant monies from several sources, such as foundations and other research organizations, to make up salary deficits and help pay for the costs above what the K award covers, such as lab needs.

Dual degree and MD physician-scientists reported a sense that they may not be as successful as a PhD-only scientist in obtaining an R grant. All thought that combining clinical training and experience with research should be more valued.

One physician-scientist described the research system as a funnel: You start in medical school, then fewer go to residency, fewer get a K award, and ever fewer get an RO1. He found this to be very discouraging.

Student loan debt was reported as a big concern among the veterinarian-scientists.

Future Plans and Influences Regarding a Research Career

Most of the physician-scientists in this study would like to stay in research and are working diligently to make that happen. They would also like to combine academics, research, and some clinical practice in their careers; most would like to eventually move into a leadership position.

Typical comments include:

"I love what I do with research, and can't see myself doing anything else. "
"It is not a terrible thing to be, you know, an academic clinician, essentially an educator, within my department and to just do that. I mean, you still get to interact with fellows. You still get to teach and you make a reasonable salary. So it wouldn't be the worst thing in the world. It is definitely not, you know, what I want to do. I would much rather be doing research. But if it came down to it, and I just couldn't sustain my research with funding, then I think that would be the way I would go. I think I am definitely not going to quit. They will have to kick me out. "

Recommendations for Strengthening the Physician-Scientist Workforce

Provide bridge funding, if needed. Several of the informants thought that the focus should be on retaining as many researchers as possible between the K award and the R awards. This is a time where many promising researchers drop out if they do not get funded for an R award right after the K award ends. This potential gap in funding is problematic and gap or bridge funding is needed. Some researchers need a little more time to obtain funding to become an independent investigator.

Increase mentor collaboration. Bring K awardees together and give advice on research careers. Protect mentor time. They are being asked to do too much, in many cases.

Consider the use of the K24 mechanism to not only train other clinical researchers, but to also mentor new physician-scientists, regardless of the type of research they are doing.

Increase K08/K23 funding to cover research technicians. K awardees reported needing funding within the KO8/K23 to pay for a research technician to keep continuity in the lab and keep the research going, especially if they are pulled out to do clinical work. Oftentimes, the lab work stops if the physician-scientist has to do clinical or academic work.

Increase all K award to five years. Three years is not enough for a K award. K awards should be at least 5 years duration.

Define protected research time in hours, not percentages.

Score proposals for R awards from K awardees, rather than triaging them. NIH has put a lot of money into K awards with the hopes that the physician-scientist will be successful in research. The young physician-scientist has sacrificed time and potentially a better salary to stay in the research track. To be able to successfully reapply for an R award, the scores and comments are very helpful in resubmissions.

Increase direct support for veterinary research. The DVM/PhDs recommended, more direct support of veterinary research that has a bearing on human health, as well as efforts to increase awareness of the availability of NIH resources/awards to DVM scientists.

Increase loan repayment options for veterinarian-scientists.

Nurse-Scientists

Past Influences on Pursuing a Career in Research

Nurse-scientists in this study reported that they love to generate new knowledge and discovery. While working previously as a clinical nurse or clinical nurse specialist, these individuals observed many research questions that were not being answered. They initially decided to get a master's degree and while in graduate school, mentors encouraged them or they became interested in continuing on to earn a research doctorate.

As one described her perspective:

"I love knowledge generation and discovery. I totally embrace that I might not be at the bedside making an impact, but that research will make an impact. This can be hard for nurse clinicians because most people don't become nurses to be researchers. Medicine and research are tied together, but not as much in nursing. It is changing a bit as we see younger nurses getting their PhDs. "

These nurse-scientists reported that there isn't a pipeline at most universities to encourage promising nursing students to consider and embark on a career in research. They also reported a absence of programs that spark an interest in nursing-related research prior to college.

Nurse-scientists tend to seek out their own mentors, based upon their research interests, even before they received their K awards.

Current Considerations about a Research Career

Nurse-scientists in this study were older when they decided to return to school to get a PhD. They first worked as either a clinical nurse or clinical nurse specialist, and then went back to earn a PhD. They were in their 40/50s when they got their K award.

Work/life balance was definitely top of mind for those with children currently at home. They did report that they have support from their colleagues and are able to resolve any work/life balance issues that may arise.

A three-year K award, which is typical for those from the National Institute for Nursing Research, is too short of a time frame to get research up and running, collect and analyze data, and then write and get manuscripts accepted in journals. Nurse-scientists reported that this has to be all done before one can write a successful proposal for an R award.

The K award does not always cover lab resources. Nurse-scientists in this study felt they needed more support in the form of lab equipment and lab space. Lab assistants are also not covered in the K award.

Nurse-scientists have to carry a larger teaching load at universities to make up salary deficits from grant funding. This can make it difficult to keep research projects moving forward. But other career options are less available:

"Nurses who want a research career are tied to academia. Some large hospitals are doing some nursing research, but not as much. "

All of those interviewed liked the idea of team science. They felt they were in a collegial atmosphere where team science works well. The nurse-scientists worked in an interdisciplinary atmosphere where team science was being used.

Future Plans and Influences Regarding a Research Career

The nurse-scientists interviewed for this study would like to stay in the research arena and teach in a university research setting. If that does not work out, they said that they can always teach and fall back on their clinical skills.

Some, but not all, have plans to apply for an R award, continuing the research they have started.

Recommendations for Strengthening the Physician-Scientist Workforce

Develop an intermediate grant that can serve as a bridge between the K award and the R grants. The K awards provide the basis for the next grant, but it may be a big jump from a K23 to an R award.

Expand K awards to five years. Three years is too short to be able to publish and reapply for the next funding grant.

Expand the K award to allow research funds to pay for laboratory-related expenses.

Institute team science in research funding opportunities. Encourage nurses and physicians to work together in team science.

Educate nurse-scientists about how to get research funding.

Moderator Guide Young Faculty

We're exploring how physician-scientists like you think about their research career decisions, and we'd like to ask you some questions about your experiences and the decisions you've made. The aggregate findings will be used to inform the deliberations of the Physician Scientist Workforce Committee at the National Institutes of Health about how to improve and support a sustainable and diverse physician-scientist workforce.

This focus group will last about 1½ hours.

A few ground rules for today's discussion:

1. Please just use your first name in your introduction and discussion.
2. We want you to do the talking and we would like everyone to participate. I may call on you if I haven't heard from you in a while.
3. There are no right or wrong answers. Every person's experiences and opinions are important. Please speak up whether you agree or disagree with what's being said.
4. What is said in this conversation will be kept private to the extent allowed by law. That is, no one person's contributions in the focus group will be identified to the Committee, and we will not provide any information from the focus group to your institution. Instead, the Committee will be provided with aggregated information to help them in their deliberations. We want you to feel comfortable sharing when sensitive issues come up.
5. We will be tape recording the group because we want to capture everything you have to say. You will not be identified by name in the report so all comments will be anonymous. The tape recordings and transcripts will be stored in a locked file cabinet until June 30, 2014 and then they will be destroyed. If anyone objects to being taped, now is the time to remove yourself from the group.

Any questions before we get started?

Public reporting burden for this collection of information is estimated to average 90 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. **An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.** Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0648). Do not return the completed form to this address.

Then let's begin. First, let's go around and briefly introduce ourselves. Can you share with us three pieces of information?:

1. Your first name
2. Your current family situation: single, married or in a committed relationship, parent (how many children and their ages)?
3. Your primary area of research

Past Influences

1. What were the most important factors that made you originally think about pursuing a career in research? (PROBE FOR: Exposure to research – family member/friend in research, Mentor, Internship/summer fellowship program, college major; college vs. university setting)
2. Approximately when in your academic career did you make the decision that research might be a good career choice for you? (PROBE FOR: approximate time if they tie the decision to an event.)
3. Have you ever had a mentor/role model in research? If so, who? How did you find your mentor?

Current Considerations

1. Just as you were making the decision to build a research career, what do you remember as appealing to you most about it?
2. Now that you have a research career in an academic center, what appeals to you most about it?
3. What are the current challenges you face in your career? (PROBE FOR: uncertainty of funding, balancing the demands of strong science and other professional demands; salary; work/family balance)
4. What would make it easier for you to continue to pursue a bio-medical research career? (PROBE for: policy changes; changes in financial support)
5. When you observe physician-scientists around you at school or in the workplace, what do you admire about them? What turns you off? (PROBE: How much would you like your career to emulate theirs? What, if anything, would you choose to do differently or would have chosen to do differently in the past?)
6. What formal activities does your school provide to encourage promising students to pursue a research career? (PROBE for: Research track? Formal mentoring program? Preceptor programs? Internships? Technological approach? If programs exist, please describe them)

Future

1. Where do you see yourself in 10 years? 20 years?
2. What kinds of things would you suggest to the Physician-Scientist Workforce Committee that would help strengthen the physician-scientist workforce?

Thank you very much!