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# National MD-PhD Program Outcomes Study

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# National MD-PhD Program Outcomes Study

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## Acknowledgments

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The MD-PhD Outcomes Project was developed and conducted in close collaboration with the directors and administrators of 80 U.S. MD-PhD programs, all of whom worked tirelessly to identify their alumni and encourage them to participate in this groundbreaking study. This study could not have been done without their help.

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# Executive Summary

Physicians who are scientists play an essential role in medicine by making important discoveries and linking those discoveries to clinical applications. They serve as a bridge between the worlds of medicine and science, worlds in which differences in language and training can make the exchange of ideas difficult. However, despite the widely accepted need for such individuals, concerns have been repeatedly raised about the size, training, and demographics of the physician-scientist workforce.[1-3] The National Institutes of Health (NIH) Physician-Scientist Workforce (PSW) Advisory Group report summarized those concerns, finding that compared with PhD scientists, few physicians are engaged in biomedical research.[4] The PSW report also showed that the physician-scientist demographic is increasingly made up of older investigators approaching retirement age. As a result, the report forecast a decline in the number of physician-scientists as older investigators retire, and too few younger investigators are available to replace them.

One of the pathways to becoming a physician-scientist is through training in an MD-PhD program. MD-PhD programs combine medical and graduate school within an integrated curriculum. Their goal is to train physicians who can combine clinical perspectives with research for a career that blends both. MD-PhD programs began on a small scale in the 1950s but currently enroll approximately 5,400 trainees in at least 90 active programs, 45 of which receive federal support in the form of National Institute of General Medical Sciences (NIGMS) Medical Scientist Training Program (MSTP) T32 grants.[5]

One of the PSW report recommendations was to sustain NIH support for MD-PhD training programs. The report concluded that MD-PhD program graduates are more likely to apply for NIH training awards than their MD-only peers, more likely to go from a training award to an independent research award, more successful when they apply for NIH research grants, and more likely to try again when their initial R01 applications failed to be funded. However, these benefits come at a high financial cost, much of which is shared by the NIH and universities. Trainees typically receive tuition waivers for both medical school and graduate school, plus a stipend. As tuition has risen, so have the costs of MD-PhD training. A recent report states that while MD-PhD program graduates are only 3% of medical school graduates each year, they receive as much as 17% of all non-need-based grants and scholarships awarded without a service commitment by U.S. medical schools.[6]

## Reasons for This Report

This study was undertaken to provide a view into the career paths of MD-PhD program graduates through 2014 and to inform key stakeholders about the impact of integrated medical and graduate training. Stakeholders in this case include MD-PhD program directors, decision makers at medical schools, leaders at funding agencies and other organizations who support physician-scientist training, and the public at large. The main goal of the study was to assess whether MD-PhD programs are collectively training a diverse cohort of men and women who can combine their clinical perspectives with high-quality research across a broad spectrum of disciplines. The study was also conducted to identify issues that need to be addressed to better accomplish the goal of training a diverse cohort of MD-PhD graduates.

In this study, the careers of most combined-degree MD-PhD program graduates over the past 50 years were tracked to determine where the graduates work, how they divide their time between research and other activities, what kinds of research they do, how successful they have been at securing research funding, whether there are sex-related outcomes differences, and how satisfied graduates are with the decision they made coming out of college to attend an MD-PhD program.

## Study Design

This study was a joint effort of the AAMC educational research community, the MD-PhD Section of the AAMC Group on Graduate Research, Education, and Training (GREAT), and the leadership of the individual MD-PhD programs. Eighty programs participated, collectively representing 91.3% of trainees enrolled in 2014 and 44 of the 45 programs that were receiving NIGMS MSTP T32 funding at the time that the data were collected. The participating programs identified 10,591 alumni. Surveys were completed in 2015 by 6,786 alumni, and the responses were combined with data for all alumni from the AAMC Student Records System (SRS), AAMC Faculty Roster, and GME Track® databases. This produced a dataset substantially larger than any previously available.[5,7,8]

## Key Findings

***Most MD-PhD program graduates are following career paths consistent with the goals of their training.*** Nearly 60% of all program alumni show up in the AAMC Faculty Roster as full-time faculty at U.S. medical schools. Among survey respondents, nearly 80% are either full-time faculty members or work for the NIH, research institutes, industry, and federal agencies. More than 80% of graduates of MD-PhD programs responded that they would definitely or probably repeat the program if they could go back in time. Their accomplishments have been recognized by election to honorary societies, including the American Society for Clinical Investigation (323), the Association of American Physicians (218), and the National Academies of Sciences, Engineering, and Medicine (22). There have been 56 Howard Hughes Medical Institute investigators, at least one Lasker Award winner, and two Nobel Prize recipients. Looking to the future, 91.2% of 2,109 survey respondents still in postgraduate training reported that their expected first workplace will be in academia, the NIH, federal agencies, research institutes, or industry. Notably, these numbers were not significantly different for men and women.

***MD-PhD program alumni are doing research, and most have research grant support.*** Of the 4,628 who responded to the survey question that asked how professional time is split in their current or most recent position, 3,564 (77.0%) indicated spending some time doing research. More than half of the survey respondents in academia or at a non-NIH institute (56.5%) have applied for NIH research support as a principal investigator. Among those who applied, 76.9% received a research grant. Furthermore, findings also demonstrate that the absence of NIH funding clearly does not equate with the absence of research funding: 86.4% of those with funding reported having support from sources other than the NIH. About half of them (51.0%) had support only from non-NIH sources, which means that they would not be expected to show up in NIH grant funding databases.

***Research time for physician-scientists in academia varies widely.*** There was no evidence of the expected bimodal distribution in which some program graduates devote most of their time to research and others are primarily clinicians. Instead, research time was a continuum: 52.7% of survey respondents with full-time academic appointments reported devoting at least half of their time to research. Only 22.7% reported devoting most of their time to clinical activities. Among instructors and assistant professors, a positive correlation was found between research effort and obtaining grant funding. Those with K awards and NIH R01s reported spending more than 70% of their time on research. Those with no grant support reported spending less than 30% of their time on research.

***Total training time is more than the time to degree, and that time continues to increase.*** For students in MD-PhD programs, total training time includes the time to degree and the time from graduation until a first position as more than a fellow or postdoc. Data in this report confirm earlier reports that the average time to degree has increased to 8.0 years for graduates in

the cohort for academic years 2004–2005 through 2013–2014, up from 6.2 years before academic year 1974–1975.[7] The median postgraduate training time to first full-time appointment in academia (including instructors) has increased to up to 6 years for graduates in the cohort for academic years 1994–1995 through 2003–2004, up from less than 3 years for the cohort prior to academic year 1974–1975.

***The number of MD-PhD program applicants, matriculants, and graduates has increased but remains smaller than projected workforce needs.*** In 2016 there were 1,936 MD-PhD program applicants, 649 matriculants, and 602 graduates.[9-11] This number of graduates is just over half the number that the PSW report estimated will be needed to sustain the workforce at current levels. In contrast, the number of medical school graduates in 2016 was 18,938.[12]

***Trainee diversity is increasing, but slowly.*** MD-PhD programs have moved in the direction of greater diversity by sex, race, and ethnicity. However, MD-PhD enrollee diversity still lags behind that of medical schools as a whole.[13] With respect to sex differences in career outcomes, the conclusions are mixed. The data for the survey respondents show that there are more similarities than differences in the career paths followed by men and women after completing MD-PhD training. However, among the alumni who did not respond to the survey, the percentage of women who showed up in the AAMC Faculty Roster as holding full-time academic appointments was considerably smaller than the percentage of men. Overall, fewer women than men are entering MD-PhD programs and fewer women are following a path to academia after graduation. Determining whether there are racial and ethnic differences in career outcomes of MD-PhD program graduates is an area for future research.

## Conclusions

Almost 80% of MD-PhD program alumni survey respondents are employed in workplaces where they can do research, develop new devices and therapies, improve public health, and help to train the next generation of scientists, physician-scientists, and clinicians. Their job mix varies, but on the whole it reflects the activities for which they were trained and responsibilities that they have been collectively asked to shoulder. Although not every applicant who enters an MD-PhD program in their early 20s remains on the path to becoming a physician-scientist, many of them do. However, the data, such as those included in the PSW report, also show that the current number of MD-PhD program graduates per year will not meet expected workforce needs, that the number of applicants per year has been insufficient to fuel substantial additional growth in program size, and that there is a need to focus on increasing diversity among MD-PhDs. As a result, other approaches to training physician-scientists have been and will continue to be required, as will measures to limit leaving the physician-scientist career path after medical school.

# Introduction

Nearly 60 years after the first MD-PhD programs were established, this report analyzes in depth the track record of MD-PhD program graduates. Using a combination of alumni surveys and AAMC databases, the report examines whether MD-PhD programs are meeting their collective goal: to train men and women who can combine their clinical perspectives with high-quality research across a broad spectrum of disciplines. Participation by the leadership of 80 MD-PhD programs, representing 91.3% of trainees enrolled in 2014, made it possible to identify and obtain information about 10,591 alumni, nearly two-thirds of whom completed an online survey about their paths since graduation. The results are critical for assessing the impact of integrated MD-PhD training, calling attention to both the accomplishments of program graduates and the issues that need to be addressed. The data are intended to be of use to those who direct MD-PhD programs, those who pay for them with public and institutional funds, and those who manage science training policies at every level.

The 2014 report of the National Institutes of Health (NIH) Physician-Scientist Workforce (PSW) Advisory Group examined the health of the physician-scientist workforce in America.[4] The results showed that the workforce is small. The most recent American Medical Association (AMA) surveys identified only 14,000 physicians (1.4% of total respondents) who consider research to be their major activity. NIH database searches identified only 8,200 physicians who are principal investigators (PIs) on NIH research grants. Although the PSW report found that these numbers have been stable for a number of years, that apparent stability hid a demographic that is increasingly made up of older investigators, an issue noted previously by others.[14] The data suggested that the size of the physician-scientist workforce has remained constant largely because older investigators have chosen to remain active longer, compensating for declining numbers of younger investigators.

Data on the average age of NIH investigators support these conclusions. The average age of research physicians has risen steadily. In 2003, 40% were over 60, and by 2012, 61% were over 60 and only 10% were under 46.[4] In parallel, the average age at the time of first NIH R01 award has increased from 37–38 in 1985 to 44–45 in 2011.[4,7,14,15] This implies a substantial increase in time from graduation to independence.[4,16] Accordingly, the PSW report forecast a decline in the size of the physician-scientist workforce as older investigators retire. The authors recommended that the NIH increase its efforts to prevent this decline. They also drew attention to the lack of diversity in the workforce and discussed the potential implications of failing to involve a larger cross section of the U.S. population in solving health-related problems.

A section of the PSW report considered the role of MD-PhD programs. These programs create an integrated curriculum that combines medical and graduate school training and currently take about eight years to complete.[7] The first organized MD-PhD program was established in the 1950s at what subsequently became Case Western Reserve University.[5] Initially programs were small and offered little beyond the opportunity to obtain both degrees at the same institution, potentially in less time than it normally took to complete them independently. Since 1964 some of the programs have received NIH National Institute of General Medical Sciences (NIGMS) support in the form of institutional T32 Medical Scientist Training Program (MSTP) training grants. With rising NIH investments, expectations for program content and trainee success have also increased. So has the total number of programs and trainees. To put the numbers in perspective, as of 2014, approximately 9,683 individuals have been appointed to MSTP T32 grants, several thousand of whom are still in training.[5] In the academic year beginning in 2015, MD-PhD programs admitted 626 new students and enrolled 5,249 total trainees.[10,17] Forty-five of the more than 90 active programs have NIGMS MSTP T32 awards that provide partial support for about 900 trainees per year.[18] The remaining support is provided by a combination of research grants, individual fellowships, and a large investment of institutional resources.[19]

## The Costs of MD-PhD Programs

The real and imputed costs of an MD-PhD program have become substantial. Most trainees receive a tuition-free education in both medical and graduate school plus an annual stipend that currently can be as high as $38,000. The intent of this high level of support is to help trainees avoid accumulating debts that could make them less likely to become physician-scientists.[6,20-22] While most trainees who enter MD-PhD programs finish, some students who begin a combined-degree program choose to finish only the MD or, less frequently, the PhD.[5,7,22] By leaving the program, they forgo additional support, but neither the NIH nor most medical schools currently require a payback of money that enrollees have already received. The net effect is that although MD-PhD trainees are only about 3% of medical school graduates each year, they receive as much as 17% of all non-need-based grants and scholarships awarded without a service commitment by U.S. medical schools.[6] At some institutions this has contributed to a reexamination of continuing MD-PhD training in its present form. It can also limit program size, since even the largest NIH MSTP T32 grants cover only a fraction of total program costs and pay only part of the cost per student.

If the costs of having an MD-PhD training program have grown, what can be said about the return on this investment? Although there is no consensus on how to best define success, relevant considerations include the career paths that program alumni have followed and their success in obtaining grant funding. The PSW report found that MD-PhD program graduates are more likely than their MD peers to apply for NIH mentored training (K08) awards, more likely to go from a K award to an independent research award, more successful when they apply for NIH research grants, and more likely to try again when their initial R01 applications fail to be funded.[4] Although the PSW analysis and a more recent analysis[5] were largely limited to graduates who had been appointed to an MSTP T32 training grant and subsequently received NIH awards, an earlier study came to similar conclusions.[23] Other studies have found that MD-PhD program graduates are more likely to become full-time medical school faculty members than medical school graduates in general. Estimates of MD-PhD alumni with full-time academic appointments have ranged from 52% to 90% in single and multi-institutional studies.[6,7,12,24-26] The comparable number for medical school graduates in general is less than 25%.[27] An analysis of individuals who completed residency training from 2006 to 2015 showed that 24% hold or have held full-time faculty appointments at U.S. medical schools. The percentage varied considerably by clinical field.[28] Note, however, that in some studies "MD-PhD" is not synonymous with "graduate of an MD-PhD program," which can make it difficult to tease out the impact of attending an integrated training program.[23,29]

Based on the data available at the time, the PSW report deemed MD-PhD programs to have been a success and recommended sustained support for MD-PhD trainees. However, the report also noted that most MD-PhD program graduates could not be found on lists of NIH-funded PIs, raising the question of whether they are actually doing research. It wasn't clear whether their absence was because of incomplete mapping between the NIH databases and the then-available lists of MD-PhD program graduates or because many of those graduates had failed to apply for grants. It was also uncertain to what extent graduates were depending on research support from sources other than the NIH. This meant that the PSW report could answer some questions about the impact of MD-PhD training, but others were left unanswered because of a lack of information.

## The Goal of This Study

Given the concerns raised in the NIH report and elsewhere about the viability, small size, and limited diversity of the physician-scientist workforce in the United States,[4,14,15,23,30] this report examines MD-PhD program graduates to determine where they work, how long it took them to get there, how they divide their professional time between research and other responsibilities, what kinds of research they are doing, whether they are satisfied with their decision to attend an MD-PhD program, how successful they have been at securing NIH funding, and whether they have obtained research support from sources other than the NIH. At the program level, the report investigates whether efforts to increase diversity and constrain growth in the time to degree have been successful.

To achieve this goal, this study was launched in 2014 as a joint effort of the Association of American Medical Colleges (AAMC), the National Association of MD-PhD Programs, the MD-PhD Section of the AAMC Group on Graduate Research, Education, and Training (GREAT), and the leadership of the individual MD-PhD programs. The active participation of the programs made it possible to identify 10,591 graduates of 80 U.S. MD-PhD programs, which collectively enrolled 4,757 of 5,209 (91.3%) trainees in 2014. Surveys were administered in 2015 and completed by 6,786 (64.1%) alumni (75.9% of the 8,944 with known email addresses). The survey results were combined with data for all of the alumni harvested from the AAMC Faculty Roster, GME Track®, and Student Records System (SRS) databases. Analyses of the data are presented in figures and tables throughout the report. In addition, there are supplemental figures and tables—referenced throughout the report and displayed in Appendix B and Appendix C—that provide additional data. The aggregate data go far beyond anything that has been gathered previously.

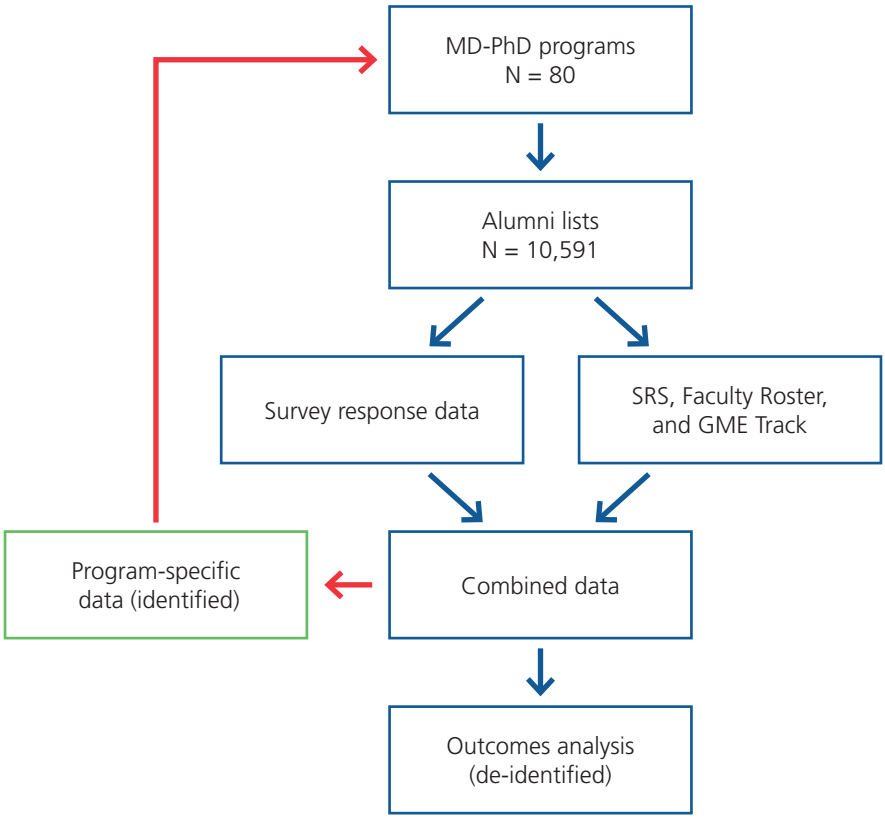
# Study Design and Methodology

This study was organized under the auspices of the MD-PhD Section of the AAMC Group on Graduate Research, Education, and Training (GREAT). Approval to conduct the survey was obtained from the AAMC Institutional Review Board. The approved survey is in Appendix A.

## Identifying Graduates

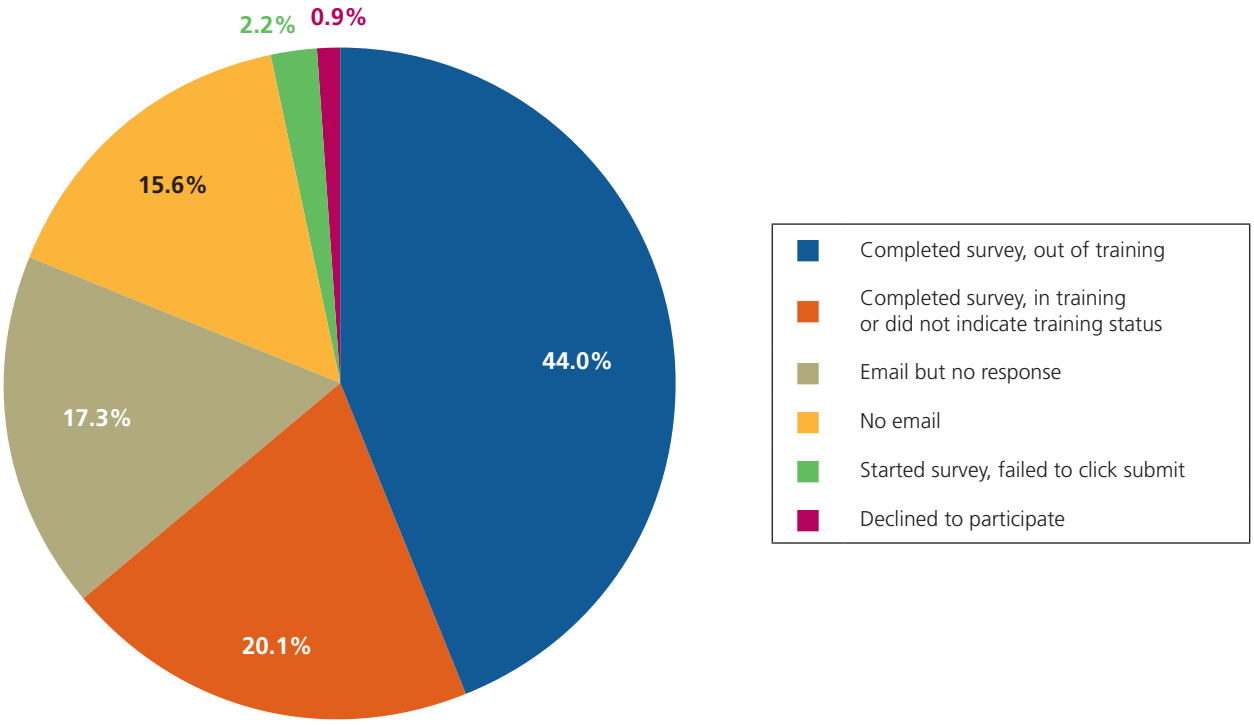
The study design is shown in Figure 1. In 2014, all MD-PhD program representatives on the AAMC MD-PhD Section listserve were contacted in advance of the study. Eighty programs, including 44 of the 45 programs with Medical Scientist Training Program (MSTP) T32 funding at the time, agreed to participate (Supplemental Table 1).[31] Collectively they enrolled 91.3% of MD-PhD trainees in 2014, based on AAMC data.[32] Each program confirmed a list of all program graduates, their email addresses, and medical school matriculation and graduation dates. This allowed the AAMC to determine the unique AAMC identification number for each graduate, which facilitated cross-referencing survey responses with AAMC databases. Through an iterative process involving AAMC Data Operations and Services staff, program administrators, and medical school registrars, the coding of MD-PhD alumni as MD-PhD recipients was verified and corrected as needed in the AAMC Student Records System (SRS) database for all the graduates of each participating program.

**Figure 1. Outcomes study data flow.** Eighty programs provided lists of alumni and email contact information to the AAMC. The AAMC cross-referenced the information with its databases to determine each graduate's unique AAMC ID number. Survey responses were combined with information from the AAMC SRS, Faculty Roster, and GME Track® databases. Each program representative received the identified person-level responses for all of their graduates who consented to share their survey responses. De-identified data were used for analysis. SRS, Student Records System; GME, Graduate Medical Education.




The programs collectively identified 10,591 graduates who could also be identified in the AAMC databases (Figure 2). Valid email addresses were obtained for 8,944 (84.4%), who constitute the survey participants. To maximize the response rate, all graduates received an email from the current director of their former program informing them that the program was participating in a national study and that they would receive an email from the AAMC with the subject line "AAMC MD-PhD Program Graduates Career Outcomes Survey" on January 19, 2015, with an individualized URL link to the survey. The survey was administered electronically using Verint software (version number 7.1.140425.128) through June 2015. After accessing the survey, participants were asked to consent to participate and to sharing their person-level identified responses with the program from which they graduated.

**Figure 2. Survey participation summary.** The numbers indicate the percentage of the 10,591 identified program alumni in each category. The total percentage adds up to more than 100% because of rounding.




## The Survey

The survey is in Appendix A. Questions 1 and 2 identified participants' current and former names. Questions 3 and 4 asked about current employment status and location. Question 5 asked if the respondent was currently in postgraduate training. If "yes," the survey automatically directed respondents to Questions 5a and 5b and then jumped to Question 13. If the answer to Question 5 was "no," the survey skipped Questions 5a and 5b and moved to Question 6. Questions 6 through 10 asked about medical specialty, time to first full-time position, first position employment sector, board certification, current position employment sector, and current academic rank. Question 11 asked whether respondents either currently hold or previously held a variety of academic and industry administrative positions. Question 12 asked about distribution of effort in percentage terms rather than hours per week; the sum had to equal 100%. For Question 13, which was about types of research, definitions were provided and respondents were allowed to choose as many types of research as they thought applicable. Question 14 asked whether respondents ever received research funding after graduation. For Question 15, concerning grant support, seven categories of funding were listed and participants were asked to check off whether they had ever applied, were currently funded, or were previously funded. Participants were able to choose more than one option and also allowed to provide information on up to three other types of funding in addition to the seven listed categories. Questions 16 asked respondents to provide a National Institutes of Health (NIH) eRA Commons username. Question 17 asked respondents whether they would opt again for MD-PhD training. Questions 18 to 20 asked about honors received, patents, and publications. Respondents were not required to answer all survey questions presented to them. Therefore, the number of respondents to each question varies and is reflected in the varied denominators used in the data analysis.

## Managing Participation

On a monthly basis, graduates who had not responded received an email from the current director of the program from which they had graduated, encouraging them to participate. This process was repeated three times. Participants who had opened but not completed the survey were sent an email in May 2015, asking them to complete the survey. By the conclusion of the data acquisition phase, 6,786 survey respondents had completed the survey. An additional 2,158 received the survey but did not return it and are referred to as nonrespondents. This includes 1,830 who received but did not open the survey; 233 who opened the survey but did not submit it; and 95 who declined to participate.

## Data Handling

Survey responses were stored on AAMC servers. Only de-identified responses were supplied to the non-AAMC investigators (MHA and LFB) after they signed AAMC data licensing agreements. Each program received an Excel spreadsheet with the identified person-level responses for the graduates of their program who consented to sharing the information. Survey responses were matched with data from AAMC databases to obtain sex, race, and ethnicity information as well as dates of matriculation and graduation. For nonrespondents and those without valid email addresses, AAMC databases provided aggregate data for graduate medical education (GME) choices and faculty status. The data analysis performed by the AAMC Data Operations and Services unit was generated by writing SQL programming using Benthic Golden software.

## AAMC Databases and Changing Data Definitions

The methods used by the AAMC to collect information on race and ethnicity changed in academic year 2002–2003 and again in academic year 2013–2014. Prior to academic year 2002–2003, individuals could only select one race/ethnicity response option even if they self-identified with more than one, and separate questions asked about an individual's Hispanic origin and race. After academic year 2002–2003, individuals could select multiple response options, but the Hispanic origin and race questions remained separate. In academic year 2013–2014, the Hispanic origin and race response options became a single question. Due to these changes, after academic year 2002–2003, the category totals may be higher than the total number of unique individuals.

The AAMC regularly updates race and ethnicity information based on the most recent entry for an individual from AAMC applications and services, such as the Electronic Residency Application Service® (ERAS®). Thus, for some individuals, the information may have been updated over time. Because of all of these changes in methodology, comparisons of data before and after 2002–2003 and 2013–2014 must be done with caution. In this report, we present the race/ethnicity responses alone or in combination with other race/ethnicity responses. If an individual identified as more than one race or ethnicity, the individual was counted in each corresponding race/ethnicity category. Determining whether there are racial and ethnic differences in career outcomes of MD-PhD program graduates is an area for future research. There may be challenges in doing a detailed analysis across cohorts by race and ethnicity, as was done with sex, because of the small early cohort sizes and the changes in methodology used to collect information about race and ethnicity.

Finally, the GME Track® database was started in 2001. As a result, residency information for anyone who graduated after 2001 comes from both the survey responses and GME Track, while residency information for graduates prior to 2001 comes solely from the survey. Thus, residency information after 2001 includes all alumni, while before 2001 residency information is limited to survey respondents.

# Results

## Participation by MD-PhD Programs and Alumni

Using the methods described in the previous section, 80 programs, including 44 of the 45 programs that had support from National Institute of General Medical Sciences (NIGMS) Medical Scientist Training Program (MSTP) T32 awards, provided information for 10,591 graduates.[33] These programs collectively represent 91.3% (4,757 of 5,209) of trainees enrolled in 2014. Email contact information was available for 8,944 (84.4% of all alumni). The online survey was completed by 6,786 respondents (75.9% of those with contact information; 64.1% of all identified alumni). Of these respondents, 4,655 (68.6% of respondents) had completed postgraduate training. A small number (95), after opening the survey, declined to participate by refusing to grant consent to participate in the survey. Another small group (233) consented to participate but did not complete the survey by clicking submit at the end of the survey. Their responses were not included in the outcomes analysis (Figure 2). Response rates were similar for men and women (Supplemental Table 2) and for self-identified white and Hispanic, Latino, or of Spanish origin respondents, but they were slightly lower for American Indians and Alaska Natives, black or African Americans, and Native Hawaiians and other Pacific Islanders (Supplemental Figure 1). The final dataset combines survey data from participants with information on all MD-PhD combined-degree program graduates from the AAMC Student Records System (SRS), Faculty Roster, and GME Track® databases.

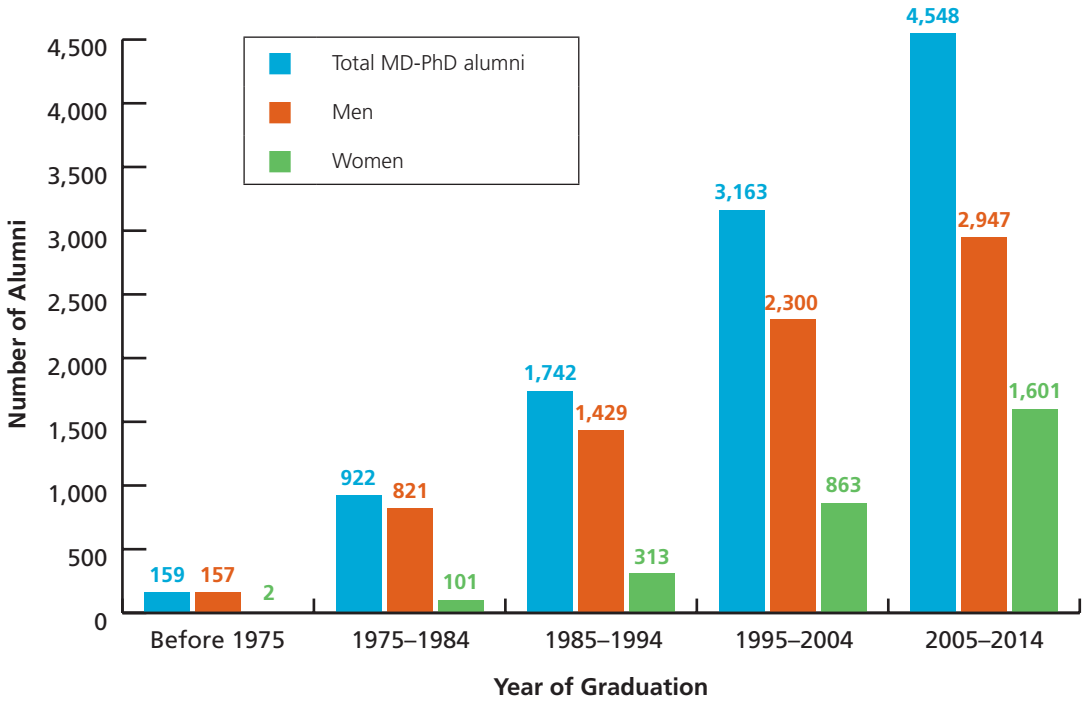
## Organization of This Report

The results are presented in three sections. The first includes demographic data and addresses issues such as the growth of MD-PhD programs as well as the sex and racial and ethnic diversity of the trainees. The second section provides a picture of the career path of program graduates once they complete medical school. The final section examines the research record of MD-PhD program alumni, focusing on how they support their research efforts and how they apportion their time.

## Section 1: Demographic Characteristics

Only 159 program graduates were identified prior to academic year 1974–1975, and all but 2 were men (Supplemental Table 2). Since then there have been large increases in both the number of active programs and the number of graduates. The percentage of women rose from 1.3% (2/159) in the cohort that graduated before academic year 1974–1975 to 35.2% (1,601/4,548) in the cohort that graduated in the decade from academic year 2004–2005 to academic year 2013–2014 (Figure 3). Overall, women constitute 27.3% (2,887/10,567) of MD-PhD program graduates. The percentage of women graduating in the most recent cohort (35.2%) approaches the percentage of women in the applicant pool. In 2014, the percentages of women applicants and matriculants to MD-PhD programs were 37% and 39%, respectively.[34] However, both of these numbers continue to lag behind medical school in general, where approximately half of applicants and matriculants are women. The percentages of women survey respondents overall and in each graduation cohort (Figure 4 and Supplemental Table 2) are nearly the same as the percentages of all women program graduates overall and in each graduate cohort (Figure 3 and Supplemental Table 2). For example, women are 28.0% of all survey respondents and 27.3% of all MD-PhD alumni.

**Figure 3. Number of MD-PhD program alumni from participating programs by sex and academic year of graduation.** All identified alumni from the participating MD-PhD programs in each 10-year cohort by year of graduation and by sex. Academic year of graduation and sex were obtained from AAMC databases for all identified program alumni. Twenty-four alumni whose sex was not listed in the AAMC databases and 33 for whom the medical school graduation year was not available were excluded from this analysis. Supplemental Table 2 contains the data used to produce this figure. For this and subsequent figures and tables, before academic year 1974–1975 is abbreviated as before 1975, academic year 1974–1975 through academic year 1983–1984 is abbreviated as 1975–1984, academic year 1984–1985 through academic year 1993–1994 is abbreviated as 1985–1994, academic year 1994–1995 through academic year 2003–2004 is abbreviated as 1995–2004, and academic year 2004–2005 through academic year 2013–2014 is abbreviated as 2005–2014.




Data for race and ethnicity were retrieved from multiple AAMC applications and services, such as the ERAS® service, American Medical College Application Service® (AMCAS®), and Medical College Admission Test® (MCAT®). Table 1 and Supplemental Figure 2 summarize the results. The groups that are considered to be underrepresented in medical and graduate education (black or African American, Hispanic or Latino of Spanish origin, American Indian or Alaska Native, and Native Hawaiian or other Pacific Islander) have also been consistently underrepresented among MD-PhD program alumni compared with medical students in general.[35]

**Figure 4. Sex distribution by year of graduation of survey respondents.** The percentage of women and men survey respondents in each academic year cohort is displayed. Sex information was not available for nine survey respondents, who were excluded from analysis. Supplemental Table 2 contains the data used to produce this figure.

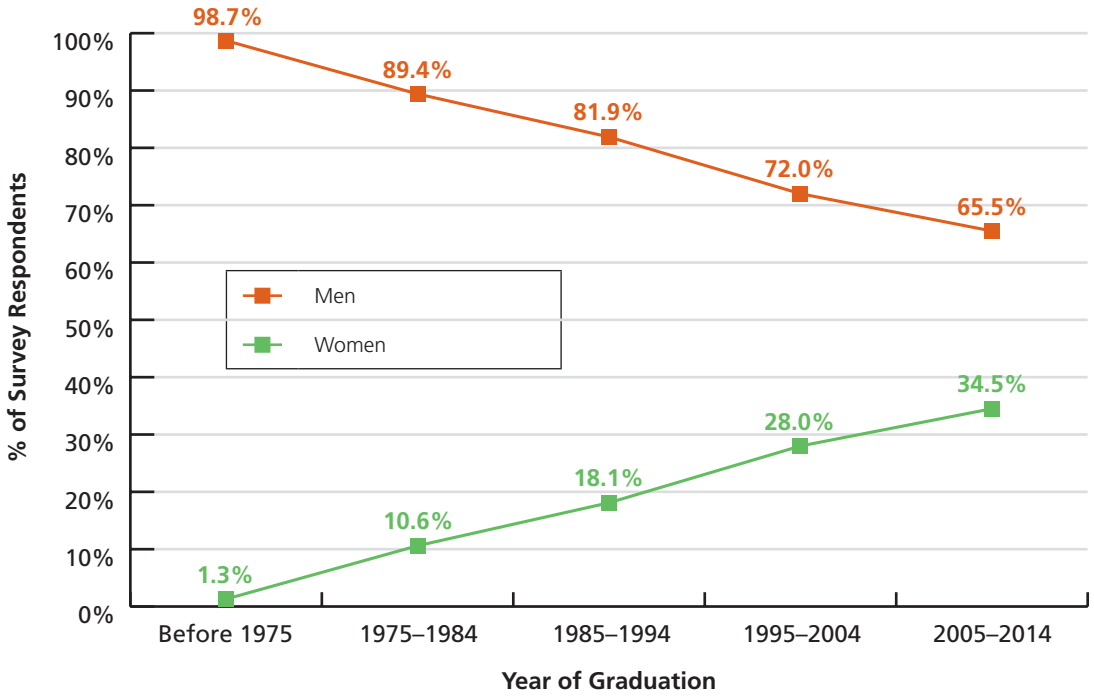



**Table 1. Race and Ethnicity of All Participating Program Alumni**

| MD-PhD Program Graduates | Before 2005 | | 2005–2014 | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| American Indian or Alaska Native | 10 | 0.2% | 27 | 0.6% |
| Asian | 941 | 15.7% | 1,016 | 22.3% |
| Black or African American | 162 | 2.7% | 235 | 5.2% |
| Hispanic, Latino, or of Spanish origin | 133 | 2.2% | 220 | 4.8% |
| Native Hawaiian or other Pacific Islander | 3 | 0.1% | 7 | 0.2% |
| White | 4,479 | 74.7% | 3,036 | 66.8% |
| Other | 19 | 0.3% | 121 | 2.7% |
| Unknown race/ethnicity | 163 | 2.7% | 3 | 0.1% |
| Non-U.S. citizen and nonpermanent resident | 102 | 1.7% | 167 | 3.7% |
| Number of unique individuals | 5,997 | — | 4,548 | — |

Note: Information about 10,545 alumni from the 80 MD-PhD programs that participated in the outcomes survey. To discern trends, the alumni are divided into those who graduated prior to academic year 2004–2005 and those who graduated in academic year 2004–2005 through academic year 2013–2014. Note that individuals who chose multiple descriptors are counted in each category. Thus, the total of each column sums to more than the number of unique individuals shown in the bottom row. The denominator for the percentages is the number of unique individuals. Thus, the percentages sum to more than 100%. A description of changes in the manner in which the AAMC collected race and ethnicity data over time is in the Study Design and Methodology section.

To identify trends, we compared graduates who finished programs before academic year 2004–2005 with everyone who graduated from academic year 2004–2005 through academic year 2013–2014. The results show an increase in the percentage of each of the underrepresented groups over this period, but the absolute numbers are small. To see whether this trend is likely to continue in the immediate future, we looked at recent applicant and matriculant records. In 2014, the proportion of black or African American; Hispanic, Latino, or of Spanish origin; and multiracial applicants to MD-PhD programs was 6.2%, 4.3%, and 6.4%, respectively. The proportion of matriculants from the same three groups was 4.1%, 5.3%, and 5.9%. In the same year the proportion of white applicants and matriculants was 45.4% and 49.2%.[36]

## Section 2: Career Path

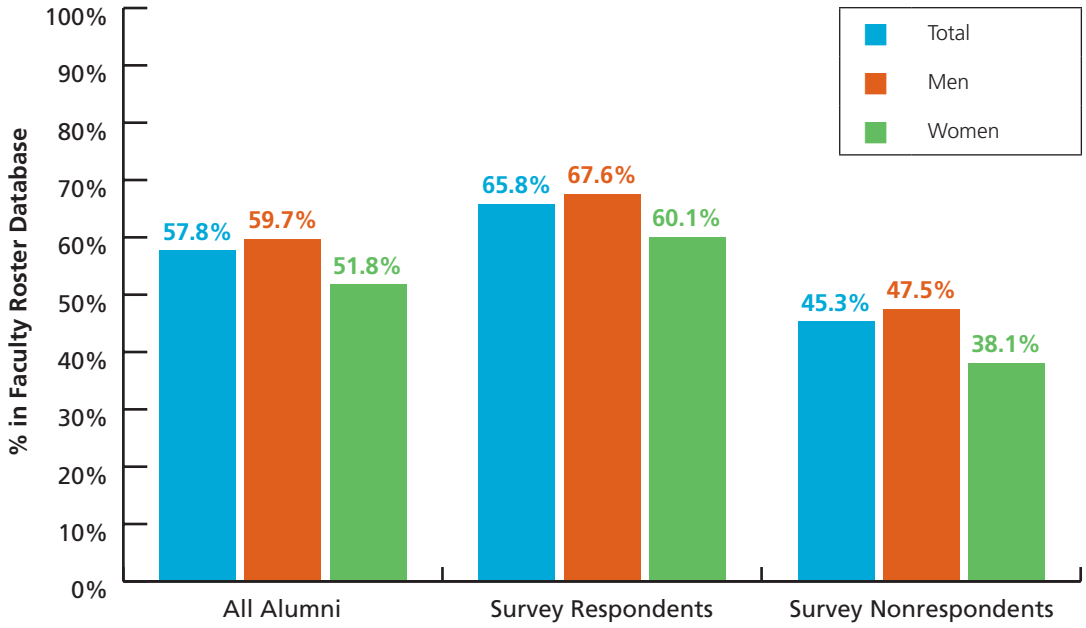
MD-PhD programs have a goal of training individuals for careers as physician-scientists. Several previous single-institution and multi-institution studies have shown that most program graduates select careers in academia.[6-8,12,16-18] The AAMC tracks medical school graduates who had a faculty appointment at medical schools at some point in their careers, but it does not normally track career outcomes outside academic medical centers. To obtain this information, we relied on the alumni survey, supplementing the results with information from the AAMC Faculty Roster. In this section, we consider a number of issues including eventual workplace choices and related trends, time to degree and time to first permanent academic position, GME choices and related trends, board certification and the maintenance of certification, and responses to the survey question, "If you could go back in time, would you opt again for MD-PhD training?"

### Workplace Choices and Trends

***Employment status.*** Although MD-PhD programs have been in existence for over 50 years, most of the alumni are still active. Of the 4,655 survey respondents who have completed postgraduate training, 4,423 (95.0%) are employed full-time, 60 (1.3%) are retired, 36 (0.8%) reported being in an employment hiatus, and 136 (2.9%) reported being employed part-time.

***Workplace choices.*** We began by using the 10,591 identified program alumni to query the AAMC Faculty Roster. There were 8,276 program graduates who were not reported as actively training in the GME Track database in 2014 and, therefore, assumed to be out of training for the purposes of this analysis: 6,269 (75.7%) men and 2,007 (24.3%) women (Supplemental Table 3). Of these 8,276 graduates, 57.8% (4,783) were listed in the AAMC Faculty Roster as having ever held a full-time medical school faculty appointment: 3,743 (78.3%) men and 1,040 (21.7%) women (Figure 5).

**Figure 5. Percentage of MD-PhD program alumni from participating programs who appear in the AAMC Faculty Roster.** The AAMC Faculty Roster was scanned for 8,276 program alumni who were not listed in GME Track® as actively training in 2014. The figure breaks these numbers down by sex and by participation in the survey. Supplemental Table 3 contains the data used to produce this figure.




Source: AAMC Faculty Roster, January 31, 2016, snapshot.

This means that overall, 59.7% of the men (3,743 of 6,269) were in the AAMC Faculty Roster but only 51.8% of the women (1,040 of 2,007). Note that these numbers are likely to be an underestimate since they only include those who hold a full-time faculty appointment at a U.S. medical school. Note also the considerable difference between survey respondents and nonrespondents: 65.8% (3,323 of 5,053) of the respondents were in the AAMC Faculty Roster, but only 45.3% (1,460 of 3,223) of the nonrespondents were (Figure 5).

To find out more about program graduates who are not medical school faculty members, we turned to the survey data. Table 2 shows the current primary workplace for the 4,645 survey respondents who have completed postgraduate training.[37] Of these, 3,025 (65.1%) reported working full-time in academia; 681 (14.7%) were in private practice. Note, however, that because the AAMC Faculty Roster data show that the career choices of the survey respondents are not necessarily a good representation of the nonrespondents, the actual percentage in private practice is likely to be higher.[38] Others are working at the National Institutes of Health (NIH) or other research institutes, at federal agencies, and in biotech and pharmaceutical industries (538, 11.6%). Among the 217 individuals who placed themselves in the Other category, nearly half could be characterized as being in private practice, but the other half includes a university president, hospital administrators, physicians working at nongovernmental organizations, venture capitalists, and a hedge fund manager.

### Table 2. Current Workplace of Respondents Who Have Completed Postgraduate Training

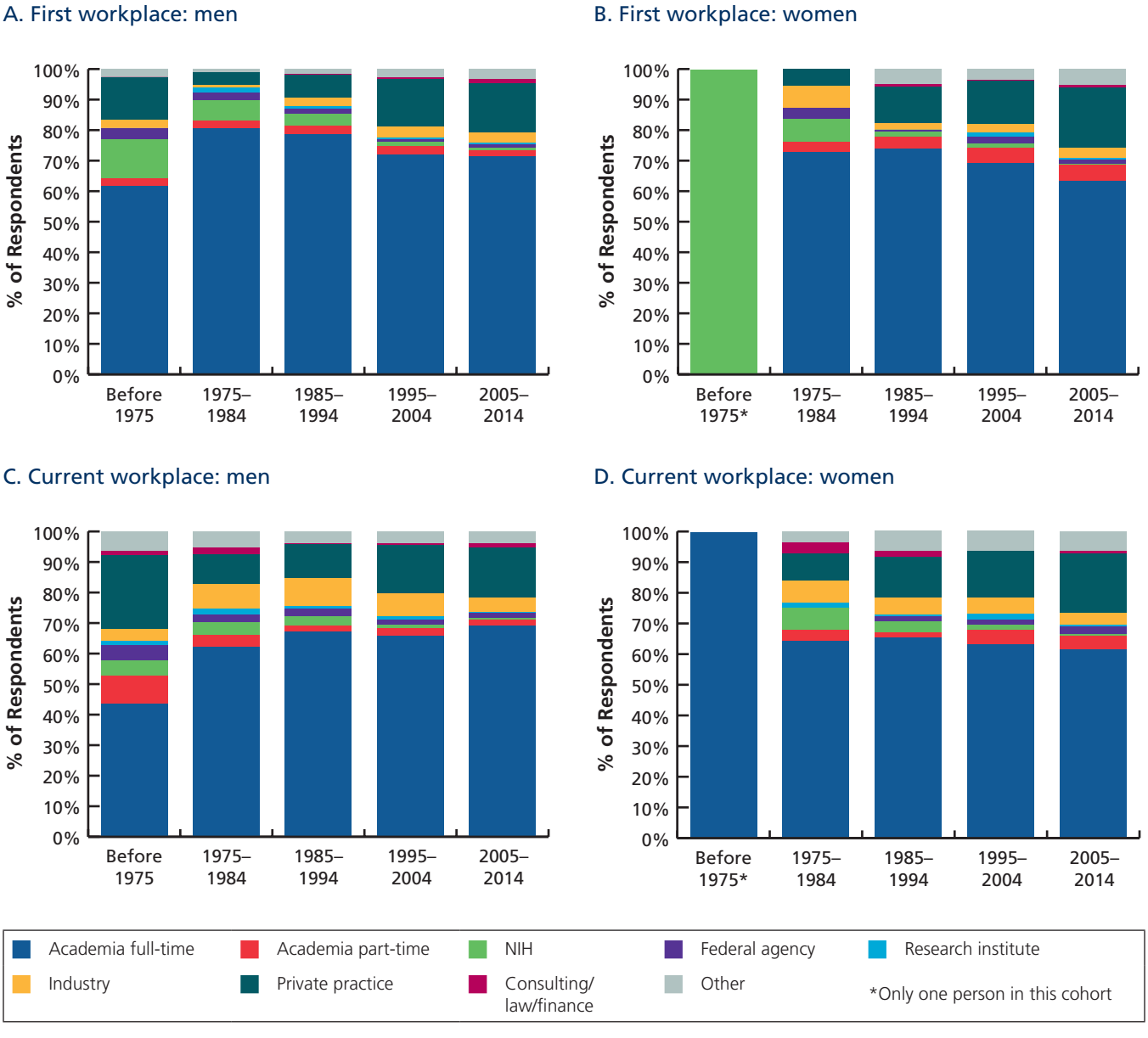
| Workplace | Total | | Men | | Women | |
|---|---|---|---|---|---|---|
| | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 3,025 | 65.1% | 2,331 | 65.8% | 694 | 62.9% |
| Academia part-time | 143 | 3.1% | 97 | 2.7% | 46 | 4.2% |
| NIH | 89 | 1.9% | 70 | 2.0% | 19 | 1.7% |
| Federal agency | 88 | 1.9% | 68 | 1.9% | 20 | 1.8% |
| Research institute | 51 | 1.1% | 38 | 1.1% | 13 | 1.2% |
| Industry | 310 | 6.7% | 254 | 7.2% | 56 | 5.1% |
| Private practice | 681 | 14.7% | 504 | 14.2% | 177 | 16.0% |
| Consulting/law/finance | 41 | 0.9% | 32 | 0.9% | 9 | 0.8% |
| Other | 217 | 4.7% | 148 | 4.2% | 69 | 6.3% |
| Total | 4,645 | — | 3,542 | — | 1,103 | — |

Note: Information provided by 4,645 survey respondents. For this and other tables and figures, federal agency refers to non-NIH agencies, research institute refers to nongovernmental research institutes, industry includes pharmaceutical and biotechnology, and private practice includes all nonacademic clinical practice. Five respondents did not answer the question and were excluded from the analysis. Five respondents for whom sex data were not available were also excluded from the analysis. Total percentages do not add to 100% because of rounding.

Overall, approximately 80% of the survey respondents could reasonably be viewed as having primary workplaces consistent with the goals of the MD-PhD programs from which they graduated. Women alumni reported being in part-time academic positions and private practice more frequently than men, but the differences were not substantial when analyzed for the entire group of survey-respondent alumni out of postgraduate training (Table 2).

***Workplace trends.*** Examining the data for trends reveals a number of interesting similarities and differences between respondents' "first workplace" and "current workplace" (Figure 6, Supplemental Table 4, and Supplemental Table 5). The percentage of graduates in each decadal cohort currently working at the NIH has decreased over time. The proportion of alumni whose first position is a full-time academic has also declined, while the proportion of those in private practice has grown. In the latest cohort (academic year 2004–2005 through academic year 2013–2014) the first position for women was less likely than for men to be in a full-time academic position (63.4% (222 of 350) vs. 71.3% (603 of 846)) and more likely to be in private practice (19.7% (69 of 350) vs. 16.0% (135 of 846)) (Supplemental Table 4). Additional follow-up will be needed to determine whether these differences increase with time. Setting aside the cohort who graduated before academic year 1974–1975, the percentage of respondents whose current workplace is in academia has remained fairly constant over time.

**Figure 6. First and current workplace for participating program alumni who have completed postgraduate training.** **A and B:** Survey responses to the question about the categorization of the first workplace after completion of postgraduate training were obtained from 3,535 men and 1,097 women. Data are shown for academia full-time, academia part-time, the NIH, federal agencies other than the NIH, nongovernmental research institutes, the pharmaceutical and biotechnology industry, and for nonacademic clinical practice, consulting/law/finance, and other. **C and D:** Survey responses to the question about the categorization of the current workplace were obtained from 3,542 men and 1,103 women. Eighteen respondents did not indicate a first workplace category, and 5 did not indicate a current workplace category. Only 1 did not provide information on either first or current workplace and described being in an employment hiatus. These 24 individuals were excluded from the analysis, as were the 9 respondents who lacked sex information in the AAMC databases. Supplemental Tables 4 and 5 contain the data used to produce this figure.



Graduates who began their careers in academia have tended to remain in academia (Figure 7). Of the 3,371 survey respondents who indicated that their first job was in academia and reported their current workplace, 2,881 (85.5%) indicated academia as their current or most recent full-time workplace, 55 (1.6%) indicated that they were working in academia part-time, 70 (2.1%) said they were working at the NIH, a federal agency, or a nonfederal research institute, and 144 (4.3%) had moved to jobs in industry. Only 149 (4.4%) moved from academia to private practice.

**Figure 7. Current workplace of participating program alumni whose first workplace was in academia full-time.**
Distribution of current workplace of 3,371 respondents whose first workplace was in academia full-time and who also reported their current workplace.

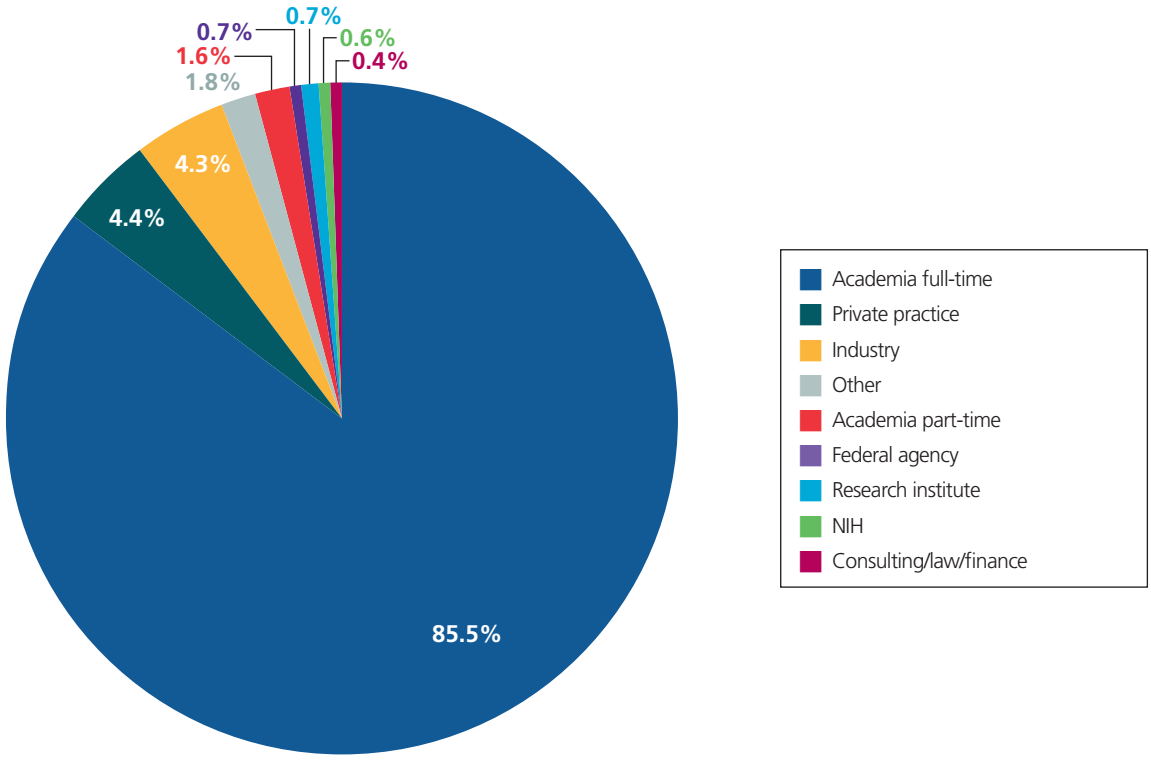
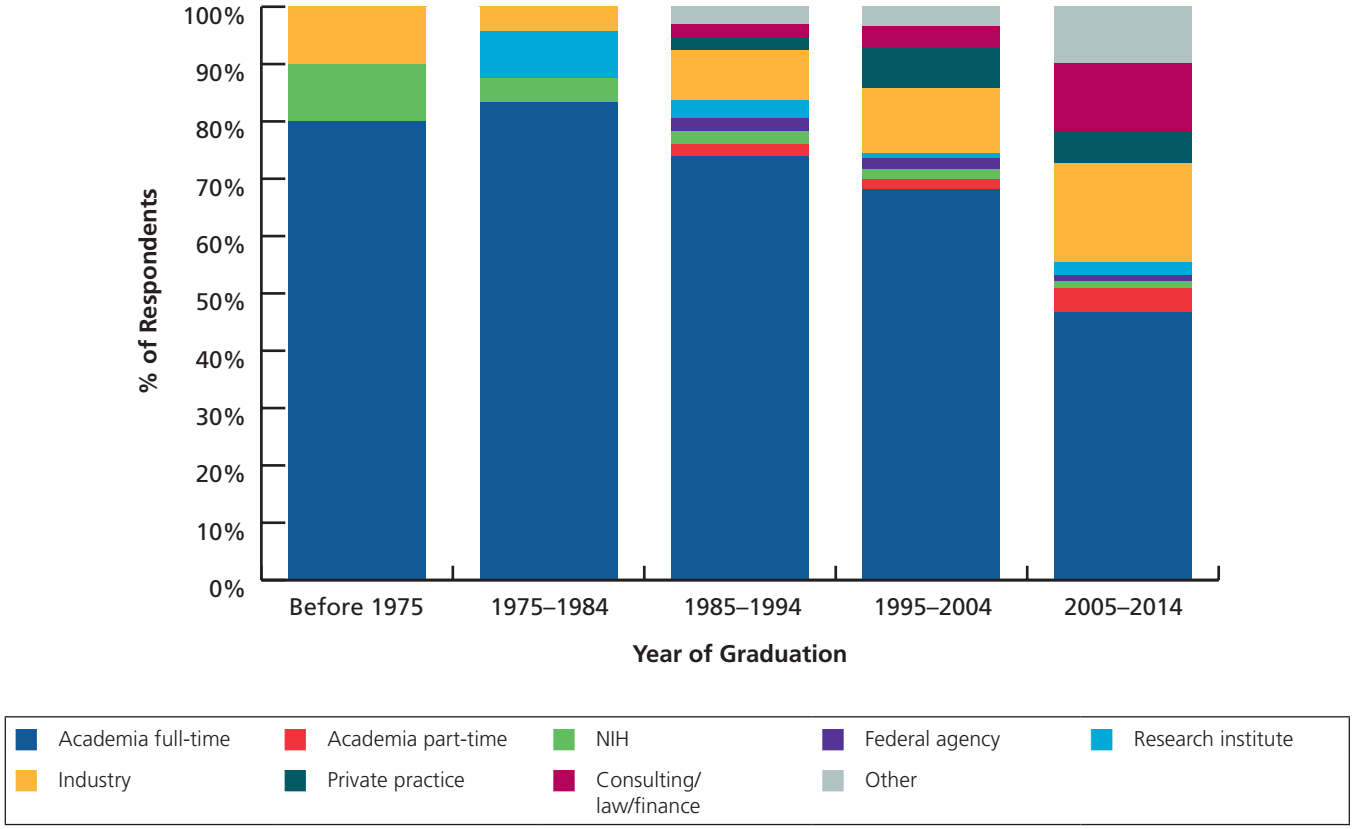


Figure 8 and Supplemental Table 6 show the first workplace choices made by 356 alumni who did not do residencies. Their most popular choice has been and continues to be academia, but the percentage choosing academia has fallen over time, to be replaced with an increase in the proportion who have chosen to work in the biotech and pharmaceutical industries.

**Figure 8. First workplace of participating program alumni who did not do postgraduate clinical training.**
Distribution of first workplace of 356 MD-PhD program graduates who chose not to do postgraduate clinical training. Numbers of individuals: 10 before academic year 1974–1975; 48 in academic year 1974–1975 through academic year 1983–1984; 92 in academic year 1984–1985 through academic year 1993–1994; 113 in academic year 1994–1995 through academic year 2003–2004; and 92 in academic year 2004–2005 through academic year 2013–2014. There is one survey participant, who responded to the first workplace question and did not complete postgraduate training, for whom a medical school graduation date is not available. Supplemental Table 6 contains the data used to produce this figure.



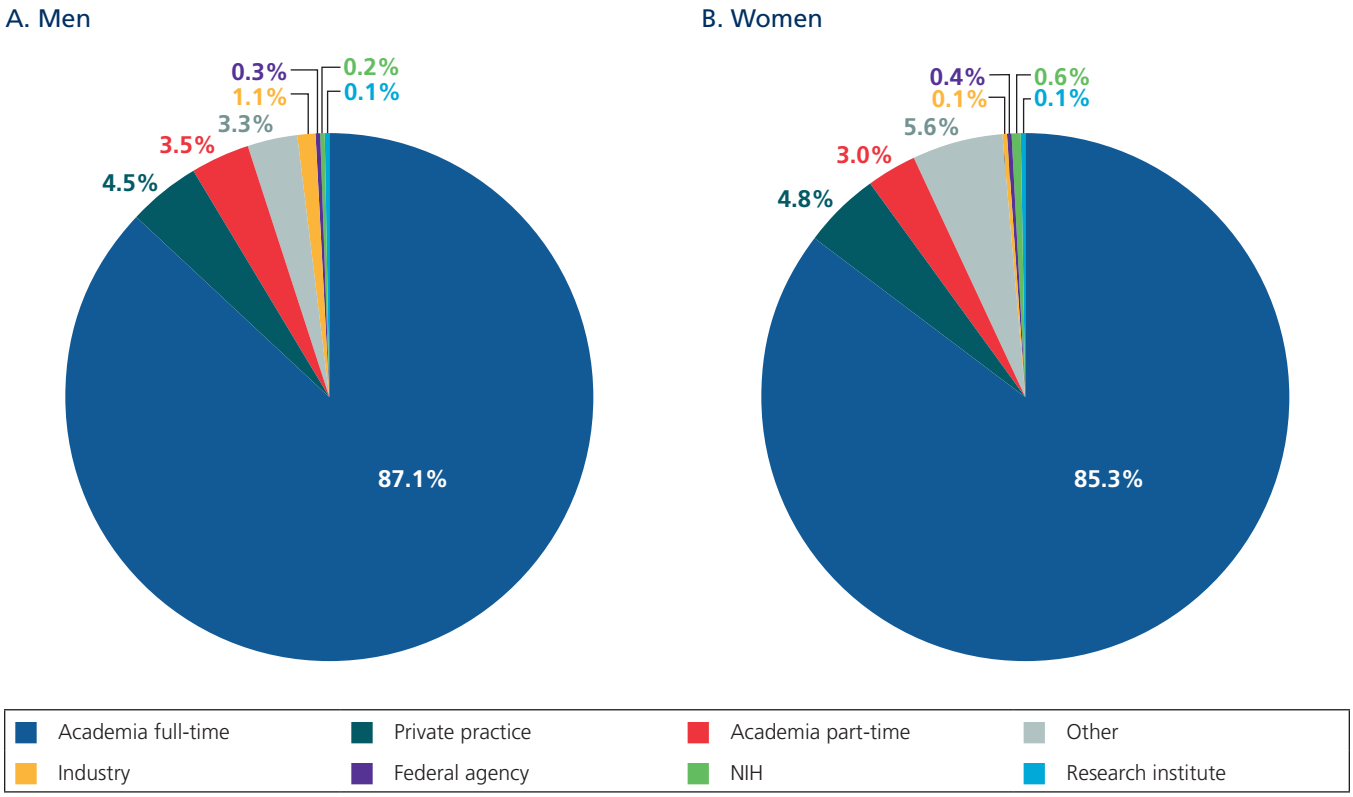
Finally, what were the plans of those who are still in postgraduate training at the time that the survey was conducted? Table 3 summarizes their responses. When asked where they hoped to work once they complete training, 1,823 (86.4%) reported plans for a full-time academic career. Only 97 (4.6%) planned to enter private practice. There were minimal differences between men and women (Figure 9).

**Table 3. Expected First Workplace After Completion of Postgraduate Training for Survey Respondents Still in Training**

| Workplace | Total | | Men | | Women | |
|---|---|---|---|---|---|---|
| | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 1,823 | 86.4% | 1,152 | 87.1% | 671 | 85.3% |
| Academia part-time | 70 | 3.3% | 46 | 3.5% | 24 | 3.0% |
| NIH | 7 | 0.3% | 2 | 0.2% | 5 | 0.6% |
| Federal agency | 7 | 0.3% | 4 | 0.3% | 3 | 0.4% |
| Research institute | 2 | 0.1% | 1 | 0.1% | 1 | 0.1% |
| Industry | 15 | 0.7% | 14 | 1.1% | 1 | 0.1% |
| Private practice | 97 | 4.6% | 59 | 4.5% | 38 | 4.8% |
| Consulting/law/finance | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Other | 88 | 4.2% | 44 | 3.3% | 44 | 5.6% |
| Total | 2,109 | — | 1,322 | — | 787 | — |

Note: Data from survey respondents who were currently in training—i.e., either in residency or fellowship programs—at the time of the survey (2015). The left two columns show the total number of respondents in each category and the percentage of the total (2,109). The central two columns show the number and percentage of men (1,322) indicating the specific category as their desired first workplace. The two columns on the right show the number and percentage of women (787) indicating the category as their desired first workplace. One survey respondent for whom sex information is not available and five survey respondents for whom graduation date information is not available are excluded from this analysis. Total percentages do not add to 100% because of rounding.

**Figure 9. Expected first workplace for participating program alumni still in postgraduate training.** Distribution of expected first workplace for 2,109 survey respondents (1,322 men and 787 women) still in postgraduate training. Seventeen respondents did not answer this question and were excluded from the figure. Table 3 contains the data used to produce this figure. Total percentages do not add to 100% because of rounding.

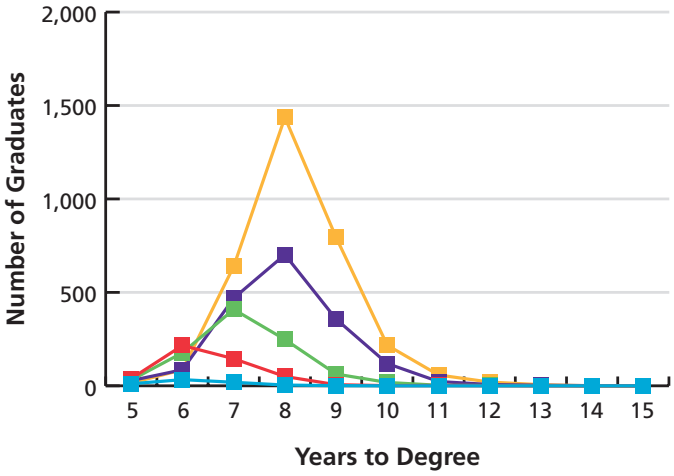


## Training Time, GME Choices, and Board Certification

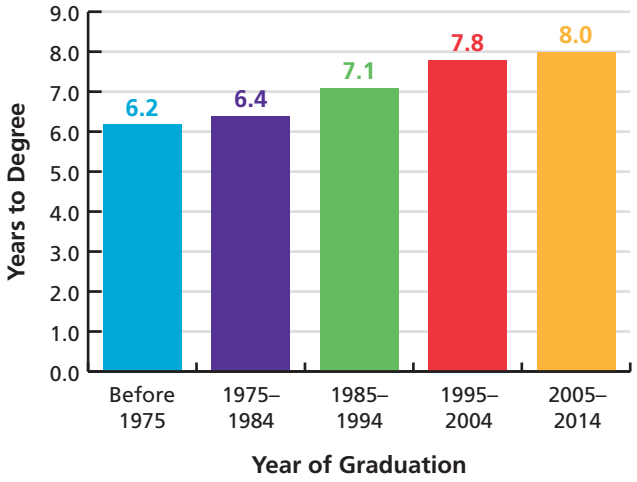
***Time to degree.*** A study of graduates from 24 MD-PhD programs that was completed in 2008 showed that there has been a substantial increase in the average time to complete MD-PhD programs since the earliest days of such programs.[7] We were able to revisit that issue in the present study, this time basing the results on the calculated difference between the dates of matriculation and graduation reported in the SRS database.[39] The results show that the average time to degree, which was 6.2 years for the preacademic year 1974–1975 cohort of graduates, has increased to 8.0 years for the most recent cohort (Figure 10). The median time to degree during the same periods was 6 and 8 years. Although the data suggest that this upward trend is leveling off, the time has not fallen.

**Figure 10. Time to degree for participating program alumni. A:** Distribution of time to degree (year of matriculation to year of medical school graduation) for 6,447 survey respondents by graduation cohort. Matriculation and graduation dates were obtained from the AAMC Student Records System (SRS) database. **B:** The average time to degree for each cohort based on year of graduation for 6,447 survey respondents is shown at the top of each bar. Note: 339 people were excluded from this analysis either because they lacked the year of matriculation or year of graduation or because the calculated time to degree was less than 5 years or greater than 16 years. Years to degree were rounded to the nearest whole number for each respondent.

A. Distribution of time to degree



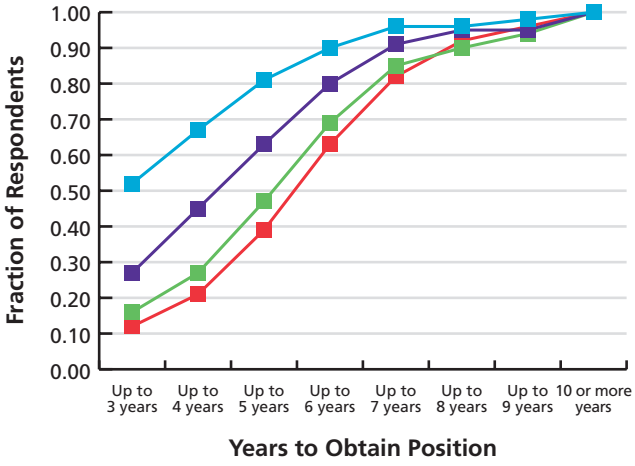

B. Average time to degree



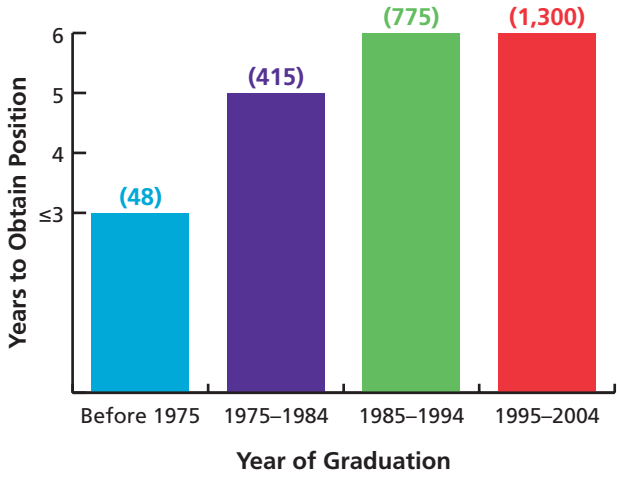

***Time to first position.*** The survey asked graduates to indicate how many years elapsed between their MD-PhD graduation and when they started their first permanent position. The data for those who are working in academia full-time are summarized in Figure 11 for graduates up to academic year 2003–2004.[40] The results are expressed as the accumulated fraction of alumni who were employed. The data confirm the upward trend in time noted in the PSW report, but the results also show that this increase may be leveling off. One cautionary note for Figure 11 is that when indicating their time to first position in academia, some alumni indicated the number of years until they became assistant professors while others included their appointment as an instructor. We were unable to disentangle this difference, which means that the time to first appointment shown in the figure may, if anything, be an underestimate of time to first assistant professor appointment.

**Figure 11. Time from graduation to first permanent position for participating program alumni whose first position was in academia full-time.** The data shown are for 3,362 alumni. Each category includes responses from the previous category. For example, "Up to 4 years" includes the responses of "3 or less years" and "4 years." The numbers of graduates in each cohort is indicated. The most recent cohort (academic year 2004–2005 through academic year 2013–2014) was omitted because 64.3% (2,131/3,316) of the cohort reported that they were still in training. Also excluded from the analysis were the 10 survey respondents whose first position was in full-time academia but for whom graduation dates are unknown.

A. Fraction of respondents who obtained their first permanent position after graduation in the number of years indicated




B. Median time to obtain a permanent position after graduation (number of respondents above each bar)




*GME choices.* Figure 12 summarizes the GME choices made by the 4,647 respondents who have completed postgraduate training. The complete dataset is in Supplemental Table 7, with a related dataset in Supplemental Table 8 showing the survey responses about GME choice from alumni who are still in postgraduate training. The data show that MD-PhD program alumni have chosen a wide range of clinical fields, but not all fields have been equally popular. The most prevalent choices were internal medicine, pathology, pediatrics, and neurology, which collectively attracted 2,753 (59.2%) alumni. The next largest field choice was surgery (329, 7.1%). Neurosurgery is the most common subspecialty choice within surgery, and hematology-oncology is the most popular subspecialty choice within internal medicine and pediatrics (Figure 13). There were no major differences in medical specialty choices by sex (Supplemental Tables 7 and 8).

**Figure 12. Residency fields chosen by participating program alumni.** Data provided by 4,647 survey respondents who have completed postgraduate training. Supplemental Table 7 contains the supporting data for this figure with the number of graduates training in each specialty by sex and graduation cohort. Respondents could select multiple specialties; therefore, the percentages add up to more than 100%.

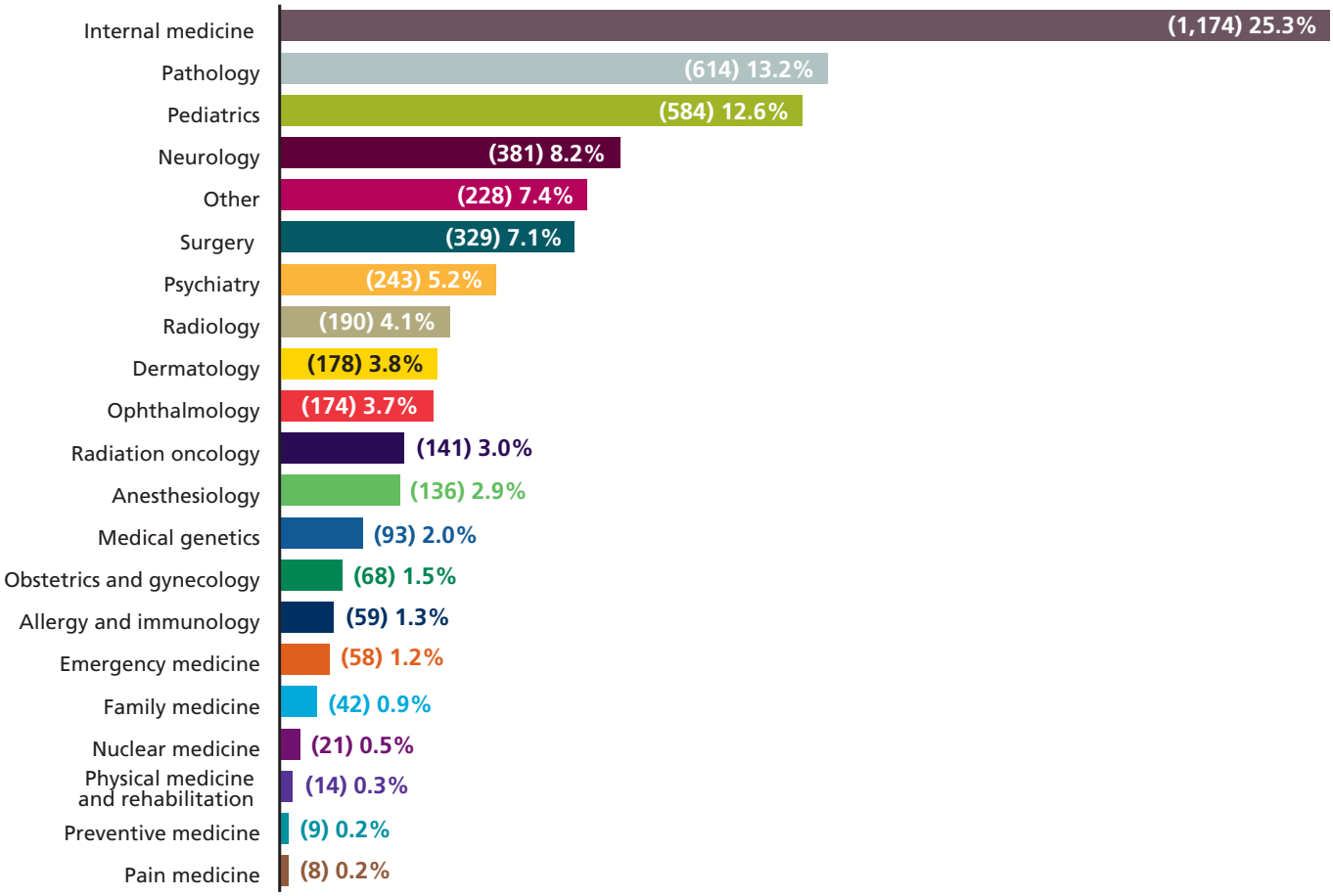
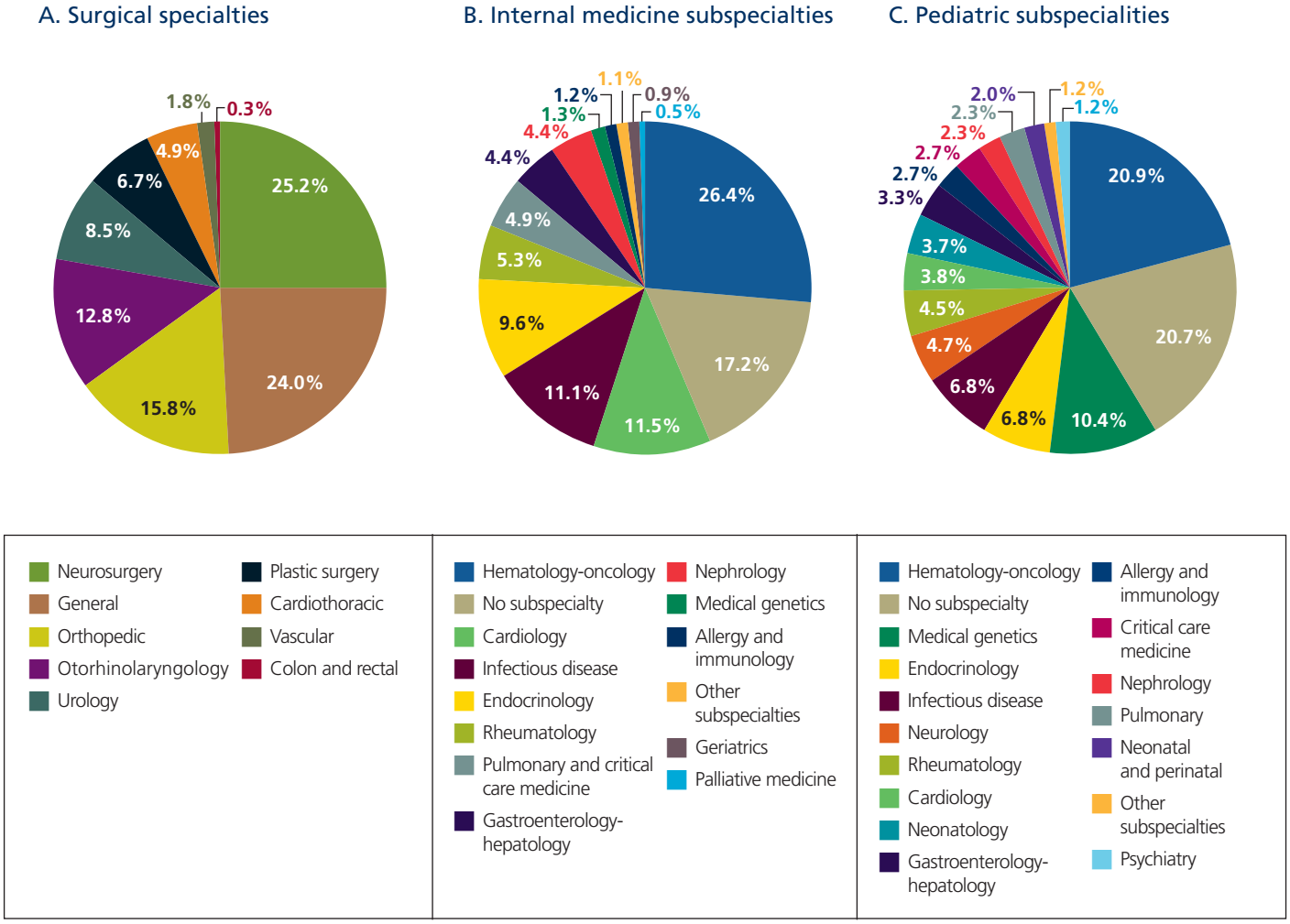


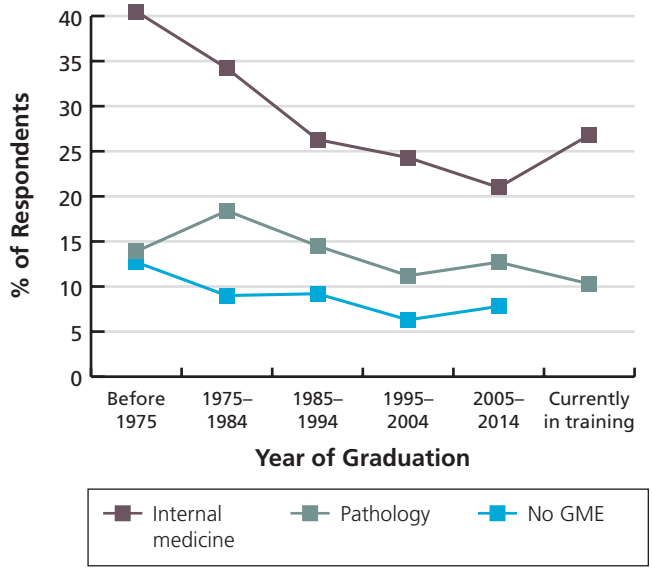
**Figure 13. Surgical specialty, internal medicine subspecialty, and pediatric subspecialty choices by participating program alumni. A:** Surgical specialties chosen by the 329 alumni who trained in them. **B:** 1,005 of the 1,214 alumni who reported training in internal medicine reported a subspecialty fellowship choice. The category Other subspecialties includes adolescent medicine (0.2%), clinical pharmacology (0.4%), hospital medicine (0.2%), primary care (0.2%), and sleep medicine (0.1%). **C:** 475 of the 583 alumni who reported training in pediatrics reported a subspecialty fellowship choice. The category Other subspecialties includes adolescent medicine (0.2%), hospital medicine (0.5%), palliative medicine (0.2%), and sports medicine (0.3%). Total percentages do not add to 100% because of rounding.



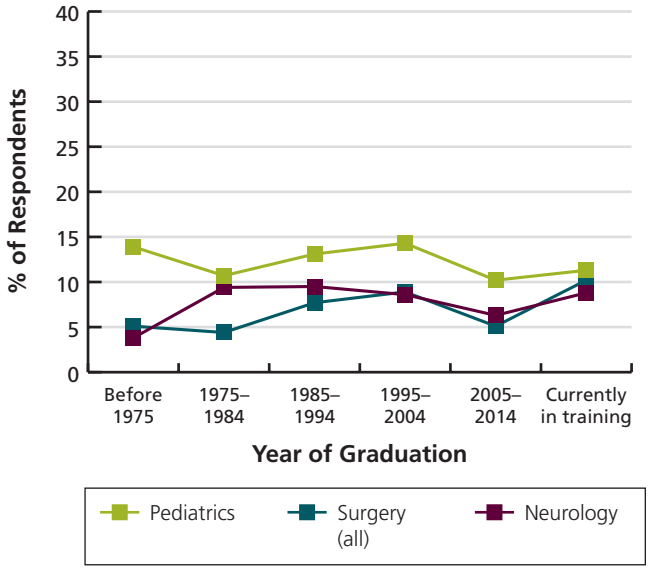

Several trends in specialty choice have occurred over time. Figure 14 shows that from the earliest cohort (preacademic year 1974–1975) to the most recent cohort (academic year 2004–2005 through academic year 2013–2014), there has been a downward trend in the proportion of alumni who have chosen to do internal medicine, although internal medicine remains the most popular choice. Smaller declines also occurred in the proportion choosing neurology and pathology. The downward trend for internal medicine may have reversed for those currently in training, but it is too soon to know for sure (Figure 14 and Supplemental Table 9).

**Figure 14. Trends in residency fields for participating program alumni.** Data for residency training by graduation cohort. **A** and **B:** Five commonly chosen specialties plus data for those who did not do residency training. The academic year 2004–2005 through academic year 2013–2014 cohort is divided into those who have completed training and those who are currently in training. Surgery (all) includes cardiothoracic, colon and rectal, general surgery, neurosurgery, orthopedic, otylaryngology, plastic surgery, urology, and vascular. **C** and **D:** Data for eight other specialties. Note the difference in y-axis scales between the top and bottom sets of graphs. Supplemental Tables 9 and 10 provide the data for this figure.

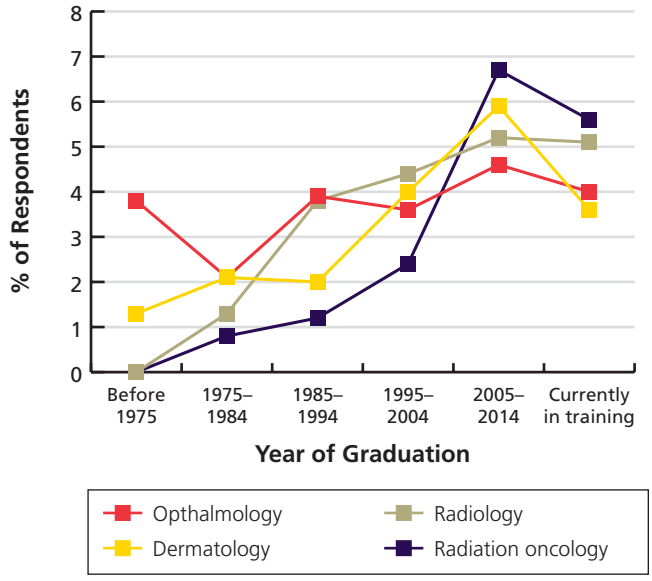
A. Trends for internal medicine, pathology, and no graduate medical education



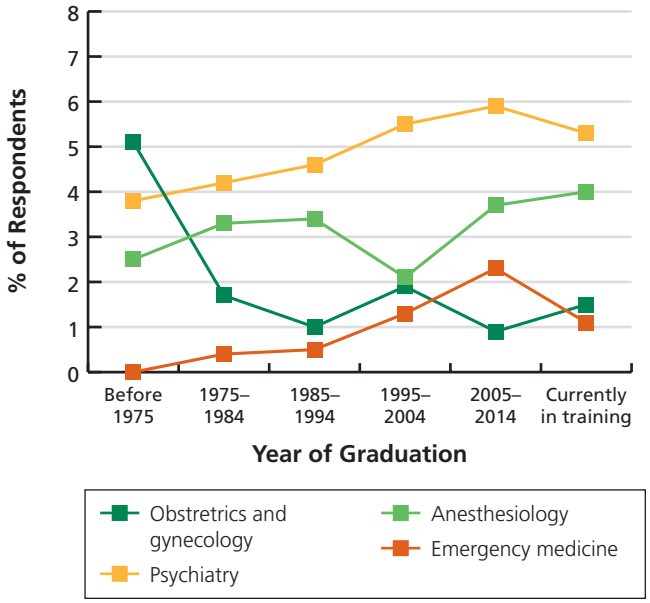

B. Trends for pediatrics, surgical specialties, and neurology




C. Trends for ophthalmology, dermatology, radiology, and radiation oncology




D. Trends for obstetrics and gynecology, psychiatry, anesthesiology, and emergency medicine



The opposite trend is seen in some of the less prevalent residency choices. Five fields (dermatology, emergency medicine, psychiatry, radiology, and radiation oncology) have all grown in popularity, although this trend has partially reversed for dermatology, emergency medicine, and radiation oncology for those currently in training (Figure 14 and Supplemental Table 10). Collectively, these five fields account for 439 (20.7%) MD-PhD program alumni who are currently in postgraduate clinical training. In general, we found no substantial differences between men and women. The full dataset is in Supplemental Table 10.

### Table 4. Residencies Chosen by MD-PhD Program Alumni

| Specialty | Total Residents | Percentage of All Residents | MD-PhD Residents | Percentage of MD-PhD Residents |
|---|---|---|---|---|
| Medical genetics | 76 | 0.1% | 14 | 18.4% |
| Radiation oncology | 678 | 0.9% | 114 | 16.8% |
| Pathology: Anatomic and clinical | 1,543 | 2.0% | 220 | 14.3% |
| Neurology | 1,658 | 2.1% | 167 | 10.1% |
| Neurosurgery | 1,199 | 1.5% | 98 | 8.2% |
| Dermatology | 1,276 | 1.6% | 76 | 6.0% |
| Nuclear medicine | 20 | 0.0% | 1 | 5.0% |
| Allergy and immunology | 223 | 0.3% | 11 | 4.9% |
| Plastic surgery: Integrated | 554 | 0.7% | 27 | 4.9% |
| Ophthalmology | 1,247 | 1.6% | 60 | 4.8% |
| Thoracic surgery: Integrated | 104 | 0.1% | 5 | 4.8% |
| Vascular surgery: Integrated | 185 | 0.2% | 8 | 4.3% |
| Internal medicine | 17,354 | 22.4% | 731 | 4.2% |
| Transitional year | 831 | 1.1% | 31 | 3.7% |
| Pediatrics | 8,040 | 10.4% | 289 | 3.6% |
| Psychiatry | 3,317 | 4.3% | 114 | 3.4% |
| Combined specialties | 1,573 | 2.0% | 47 | 3.0% |
| Radiology: Diagnostic | 4,151 | 5.4% | 119 | 2.9% |
| Urology | 1,186 | 1.5% | 30 | 2.5% |
| Anesthesiology | 4,881 | 6.3% | 106 | 2.2% |
| Otolaryngology | 1,484 | 1.9% | 32 | 2.2% |
| Preventive medicine | 191 | 0.2% | 4 | 2.1% |
| Pain medicine (multidisciplinary) | 197 | 0.3% | 4 | 2.0% |
| Surgery: General | 6,912 | 8.9% | 114 | 1.6% |
| Physical medicine and rehabilitation | 659 | 0.9% | 8 | 1.2% |
| Obstetrics and gynecology | 3,802 | 4.9% | 43 | 1.1% |
| Orthopedic surgery | 3,748 | 4.8% | 36 | 1.0% |
| Emergency medicine | 4,890 | 6.3% | 37 | 0.8% |
| Thoracic surgery | 154 | 0.2% | 1 | 0.6% |
| Plastic surgery | 309 | 0.4% | 2 | 0.6% |
| Family medicine | 5,019 | 6.5% | 26 | 0.5% |
| **Total residents** | **77,461** | — | **2,575** | — |

Note: GME specialties in 2014 are ranked by the percentage of MD-PhD program graduates (MD-PhD residents divided by total residents) from highest to lowest. MD-PhD students represent approximately 3% of medical students graduating each year. Using 3% as the cutoff, the shaded rows indicate fields in which MD-PhD program graduates are underrepresented. The percentages of all residents do not add to 100% because of rounding. Data from AAMC Table B4: MD-PhD Residents, by GME Specialty, were used to help create this table (aamc.org/data/448484/b4table.html, accessed on May 2, 2016).

Although approximately 3% of resident physicians in 2014 were graduates of MD-PhD programs (2,575/77,461), the proportion of MD-PhD residents in any given field varied from 18.4% (14/76) in medical genetics to 0.5% (26/5,019) in family medicine (Table 4). Despite its popularity among MD-PhD program graduates, only 4.2% of internal medicine residents were MD-PhD program alumni (731/17,354). This lags behind pathology and neurology at 14.3% (220/1,543) and 10.1% (167/1,658), while radiation oncology, which trains only 0.9% of all residents, had a residency population that was 16.8% MD-PhD program alumni (114/678).

***Board certification and the maintenance of board certification.*** Requirements for recertification and maintenance of board certification have increasingly been discussed by physicians in the past decade.[41,42] In the survey we asked MD-PhD program alumni to indicate whether at any point in their career they had been certified by the American Board of Medical Specialties (ABMS) and, if so, whether they are maintaining active certification. If they are not maintaining active certification, we asked them to tell us why. The results are summarized in Table 5 for all survey respondents through 2004. The data show that over 80% of program graduates have become board certified. Nearly all of the academic year 1994–1995 through academic year 2003–2004 cohort are maintaining certification or have not yet reached the point where they are required to do so, but 17.2% (11 of 64) of respondents before academic year 1974–1975 who became board certified have chosen to not maintain certification.

### Table 5. Board Certification of Respondents Who Have Completed Postgraduate Training by Medical School Graduation Year

| Certification Status | Before 1975 | | | | 1975–1984 | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Men | Women | Percentage of Women | Total | Men | Women | Percentage of Women |
| Number of survey respondents | 79 | 78 | 1 | 1.3% | 526 | 470 | 56 | 10.6% |
| Board certified by ABMS | 64 | 63 | 1 | 1.6% | 417 | 372 | 45 | 10.8% |
| Maintaining certification | 53 | 52 | 1 | 1.9% | 376 | 338 | 38 | 10.1% |
| % who became board certified | 81.0% | 80.8% | 100.0% | — | 79.3% | 79.1% | 80.4% | — |
| % who have NOT maintained certification | 17.2% | 17.5% | 0.0% | — | 9.8% | 9.1% | 15.6% | — |

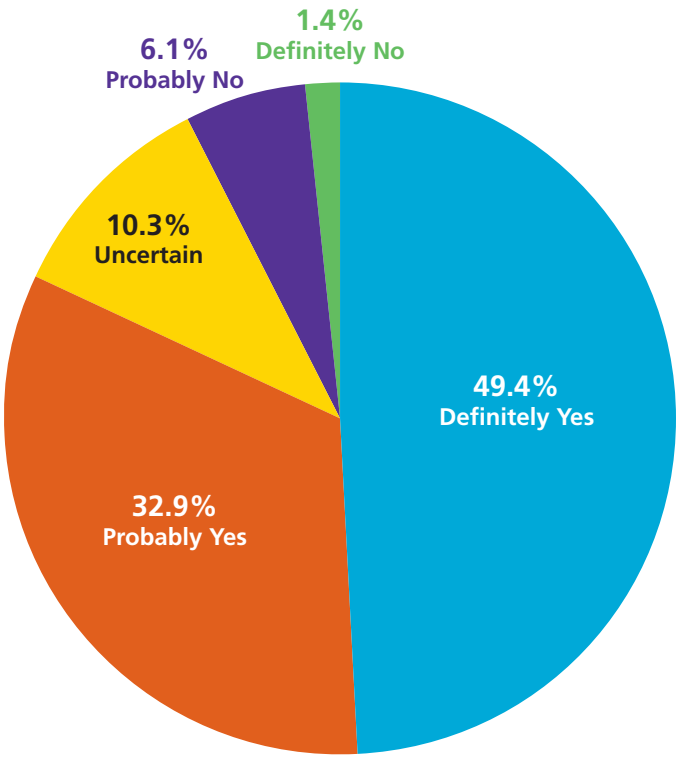
| Certification Status | 1985–1994 | | | | 1995–2004 | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Men | Women | Percentage of Women | Total | Men | Women | Percentage of Women |
| Number of survey respondents | 1,000 | 819 | 181 | 18.1% | 1,852 | 1,334 | 518 | 28.0% |
| Board certified by ABMS | 843 | 699 | 144 | 17.1% | 1,595 | 1,149 | 446 | 28.0% |
| Maintaining certification | 750 | 622 | 128 | 17.1% | 1,543 | 1,107 | 436 | 28.3% |
| % who became board certified | 84.3% | 85.3% | 79.6% | — | 86.1% | 86.1% | 86.1% | — |
| % who have NOT maintained certification | 11.0% | 11.0% | 11.1% | — | 3.3% | 3.7% | 2.2% | — |

Note: Data for survey respondents graduating before academic year 2004–2005 by graduation cohort. It should be noted that "maintaining active ABMS certification" was not defined in the question and "maintenance of certification (MOC)" was not specifically mentioned in the survey. This may limit the interpretation of the responses, especially for those who were certified prior to about 1990, because until then board certification was a lifetime certification and not time limited. Thus, it is unclear why graduates in the cohorts before academic year 1974–1975 and academic year 1974–1975 through academic year 1983–1984 might indicate that they are not maintaining active certification and how the respondents interpreted the phrase "active certification." The years after academic year 2003–2004 were omitted because of the large number of graduates in those years who have not yet completed postgraduate training. Nine survey respondents for whom sex data were not available were excluded from the analysis. Additionally, there are 23 total survey respondents for whom medical school graduation dates are not available. ABMS, American Board of Medical Specialties.

Reasons for not maintaining certification were provided by 197 alumni. The three most common reasons were that they had stopped seeing patients and were focusing more on either research or administration, the burden of maintaining certification, and retirement. Some respondents noted that maintaining certification was irrelevant for their current position and others noted they had been granted permanent certification before the present system of 10-year limited duration certification was initiated. We observed no sex differences with respect to either becoming certified or maintaining certification.

***Would you do it again?*** As a final question for the career path section of this study, we asked program alumni to tell us whether they would make the choice to enter an MD-PhD program again if they could start all over. The overwhelming choice was positive, with 5,562 of 6,758 respondents (82.3%) choosing "definitely yes" or "probably yes" and only 92 (1.4%) answering "definitely no" (Figure 15).

**Figure 15. Satisfaction with MD-PhD training of participating program alumni.** Responses of 6,758 survey participants to the question, "If you could go back in time, would you opt again for MD-PhD training?"



## Section 3: Research Record

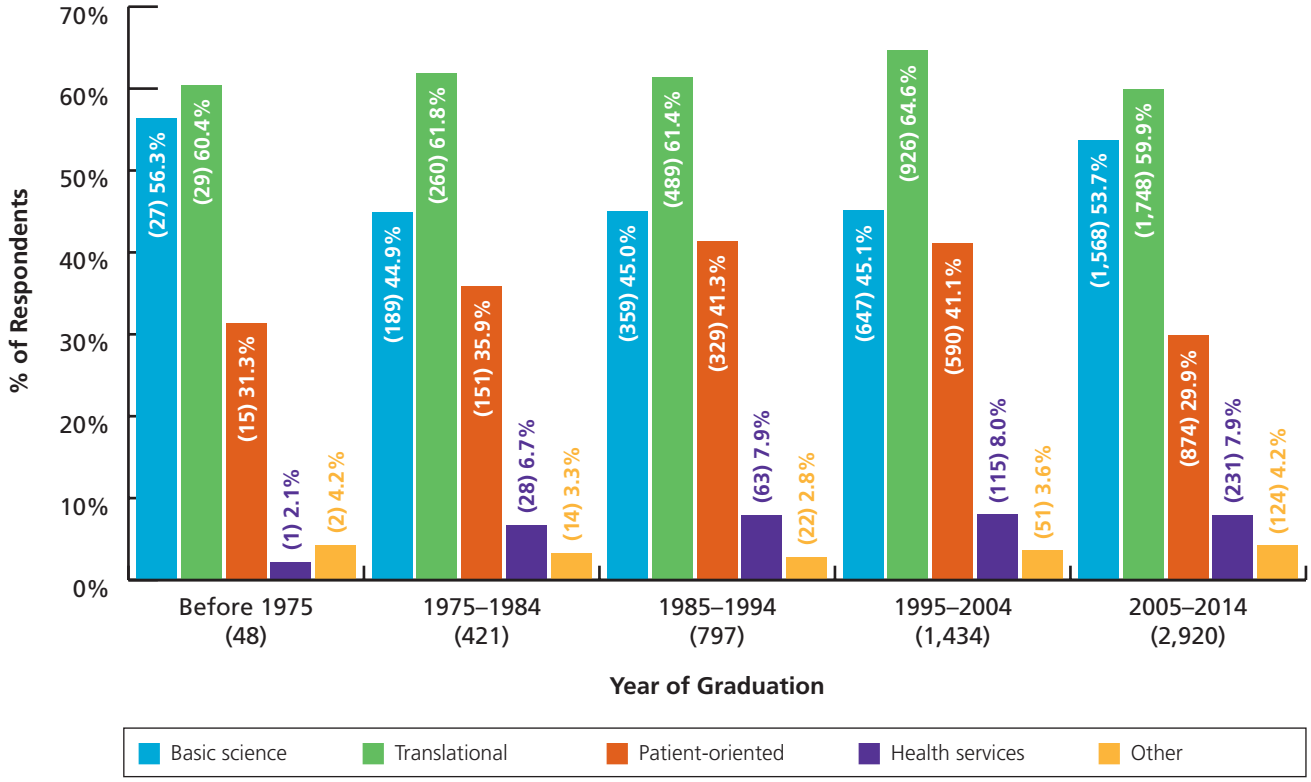
MD-PhD programs are intended to train men and women who will be investigators as well as clinicians. The survey data allowed us to ask questions that had not previously been answered for large numbers of alumni. Which kinds of research are they doing? How do they distribute their professional effort between research and other activities, including clinical care? How do they fund the research that they do?

### Types of Research and Distribution of Effort

***Types of research.*** We asked program alumni to indicate whether they do basic, translational, patient-oriented, or health services research. Basic science research was defined in the survey as "fundamental theoretical or experimental investigative research to advance knowledge without a specifically envisaged or immediately practical application. It is the quest for new knowledge and the exploration of the unknown."[43] Translational research was defined as "the process of applying ideas, insights, and discoveries generated through basic scientific inquiry to the treatment or prevention of human disease."[44] Patient-oriented research included clinical trials. Health services research included exploration of health disparities/inequities, health outcomes, behavioral interventions, and community participatory research. Participants were asked to characterize the type of research they were conducting at the time of the survey and could choose multiple categories. Space was left to write in any other types of research.

The results are summarized in Figure 16. Of the 6,786 alumni whose graduation dates and sex were available, 5,620 (82.8%) responded to the question about whether they do research and indicated that they are involved in at least one type of research. The largest proportion of the alumni, approximately 60% across all cohorts, or 3,452 in total, indicated that they were doing translational research. Basic science research came second, with the highest percentages for the alumni who graduated before academic year 1974–1975 (27, 56.3%) and after academic year 2004–2005 (1,568, 53.7%). Patient-oriented research was third. Relatively few reported doing health services research: 1 (2.1%) in the preacademic year 1974–1975 cohort and between 28 and 231 (7%–8%) in all subsequent cohorts. However, many of the health service researchers reported doing other types of research as well, especially patient-oriented and translational research. Alumni who indicated that they do translational research tended to do basic and patient-oriented research as well. There were 213 graduates of the 5,620 respondents who indicated that they do "other" kinds of research. Among the examples provided were education research, drug or device development, epidemiology, informatics, global health, social science, and bioethics.

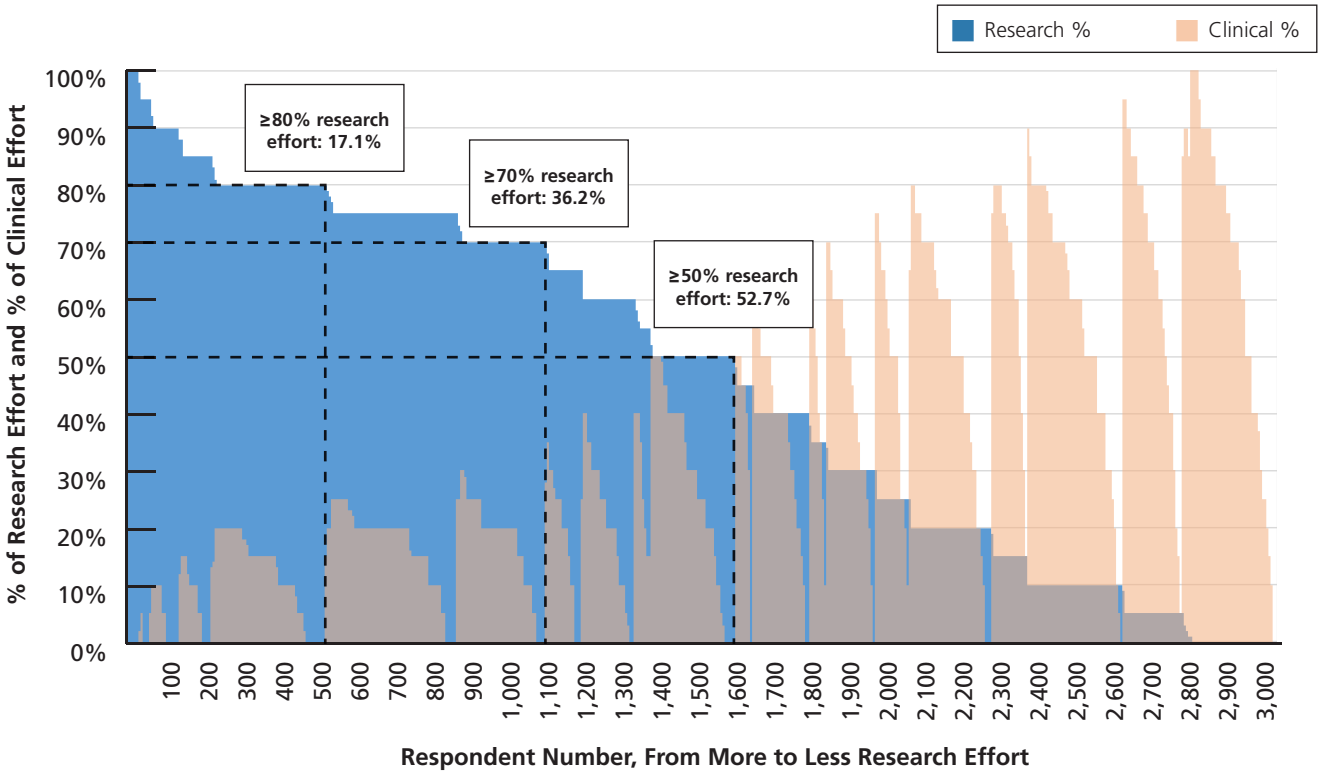
**Figure 16. Types of research being conducted by participating program alumni.** The types of research being conducted at the time of the survey by 5,620 respondents, reported by year of graduation. Basic, translational, patient-oriented, and health services types of research were defined as indicated in the text. Survey respondents were able to select more than one type of research. There were 32 survey respondents who were excluded because either their sex or graduation dates were unavailable. Note that the percentages can sum to more than 100%, because the denominator is the number of unique individuals. The unique number of respondents in each cohort is indicated in parentheses along the x-axis.




***Distribution of effort for alumni in academia.*** Among survey respondents reporting their sex information, 65.1% (3,025 of 4,645) of those who have completed postgraduate training hold full-time academic appointments. We asked them to tell us how they apportion their time among research, clinical care, teaching, administration, and consulting. Teaching was defined as including classroom lectures, small group preceptorships, and teaching in the clinical setting. Time spent teaching the students and postdocs in their laboratory was included in research time. We also gave an option of listing other activities and the proportion of time spent on them. We did not define the length of the work week or ask respondents to relate activities to the sources of their salary support, as is often done. Instead, we only asked that the sum of all of their effort should be 100%.

Research effort proved to be a continuum of values rather than, for example, a bimodal distribution, which would have indicated that some alumni spend most of their time on research while others spend little or no time (Figure 17). Although only 17.1% (518 of 3,025) of individuals reported devoting 80% or more of their time to research, 52.7% (1,593 of 3,025) reported devoting at least half of their time. Notably, within each range of percentage effort for research shown in Figure 17, the amount of time devoted to clinical responsibilities varies considerably, reflecting variations in the amount of time spent on other activities. When these data are replotted as a histogram based on clinical effort, the results are also a continuum (not shown). However, in contrast to research effort, only 22.7% (687 of 3,025) reported devoting more than half of their time to clinical activities.

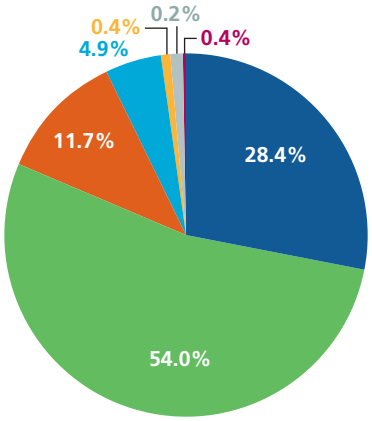
**Figure 17. Research and clinical effort reported by participating program alumni employed in academia.** Responses by 3,025 survey participants working in academia full-time to the survey question about how they apportion their effort. The histogram shows percentage research and percentage clinical effort for each of the individuals who responded, arranged from left to right by decreasing research effort. The markers show the percentages of respondents who reported more than or equal to 80%, 70%, and 50% research effort. Three survey participants working in academia full-time did not respond to the question about how they apportion their effort.



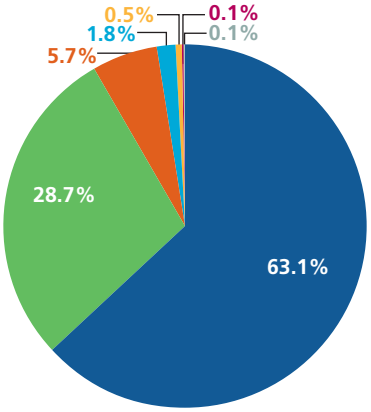

Finally, we looked for relationships between research effort and obtaining grant awards. We focused on those making the transition to independence, the 774 instructors and assistant professors in the academic years 2004–2005 to 2013–2014 cohort of 3,303 respondents (Figure 18). Respondents could choose more than one category of grant support. Approximately half (345, 44.6%) of this group had yet to receive research funding, and their average effort devoted to research was 28.4%. Among the 774 respondents, 20.9% (162 of 774) reported having NIH mentored career development (K) awards, and a small percentage (5.6%, 44 of 774) were principal investigators (PIs) on NIH research grants. Their effort devoted to research was 77.1% and 73.5%, respectively. For the 356 who reported non-NIH sources of grants, their effort devoted to research was 63.1%. Clinical care effort varied inversely with research effort. Time devoted to research was greatest for those with NIH grant support. Notably, those 162 alumni who are PIs on an NIH mentored career development (K) award report devoting an average of 77.1% effort to research, consistent with the NIH mandate for 75% research effort for mentored K award recipients.

**Figure 18. Effort distribution for participating program alumni who are instructors and assistant professors.** Data for the 774 instructors and assistant professors in the academic year 2004–2005 through academic year 2013–2014 graduation cohort based on the type of grant support obtained. Average percentage of time spent on research, clinical care at an academic medical center, teaching, administration, and other activities (combination of nonacademic clinical practice, consulting, and other activities) was calculated based on grant support obtained. Individuals may have multiple awards, therefore the sum of the categories is more than the total number of individuals. PI, principal investigator.

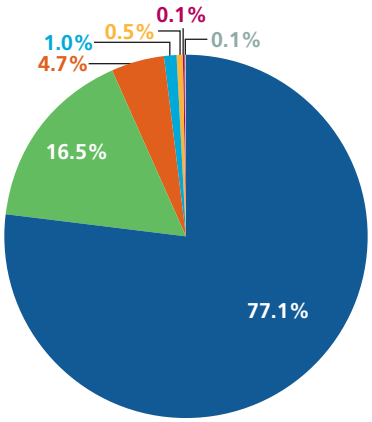
A. No current grant support (N = 345)



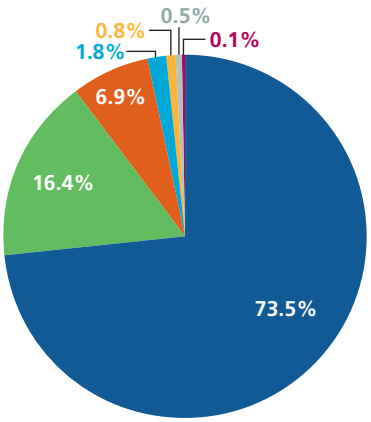

B. Current PI on non-NIH grant (N = 356)

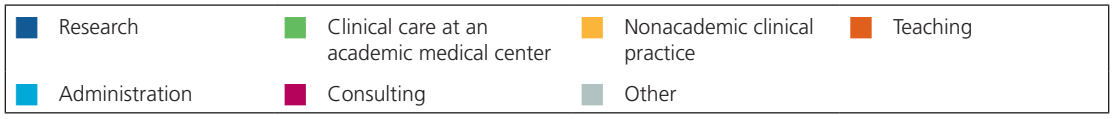



C. Current NIH mentored career development award (N = 162)




D. Current PI on NIH research grant (N= 44)



## Sources of Support

***Research support.*** Potential sources of funding that were listed in the questionnaire included NIH mentored career development (K) awards, NIH research grants (R, P, and U types), other federal agencies (examples were the National Science Foundation, the Department of Veterans Affairs, the Centers for Disease Control and Prevention, the Department of Defense, and the Food and Drug Administration), private foundations (examples were the American Heart Association, the American Cancer Society, and the Cystic Fibrosis Foundation), Pharma/Biotech, and Other. Of 3,583 program graduates who reported funded research, 1,889 (52.7%) reported applying as a PI for a research grant from private foundations at some point in their careers.

Table 6 summarizes the data for NIH research grant applications by survey respondents working in academia or at a research institute other than the NIH. There were 2,993 respondents for this question. Of these, 1,692 (56.5%) had applied for NIH research grants as a PI and 1,301 (43.5%) had received awards, giving a 76.7% success rate for those who applied. The success rate for women (72.0%) was slightly lower than for men (77.9%), although this apparent difference may reflect the relative paucity of women in the earliest graduation cohorts. Women constituted only 17.7% (300/1,692) of those who applied but are 24.3% of all graduates out of training.

**Table 6. Success Rates for Obtaining NIH Research Grants of Select Participating Program Alumni**

| NIH Grants | Total | Men | Women |
|---|---|---|---|
| Ever applied for an NIH research grant | 1,692 | 1,392 | 300 |
| Previously and/or currently funded as PI | 1,301 | 1,085 | 216 |
| Success rate | 76.9% | 77.9% | 72.0% |

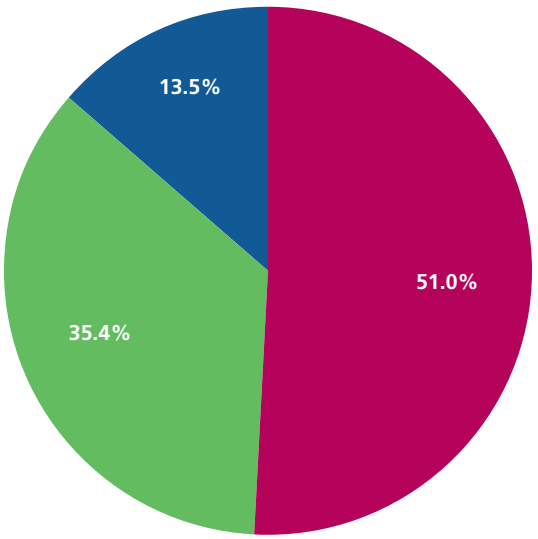
Note: Self-reported funding success for NIH research grant applications by MD-PhD program graduates with a current position in academia or at a nongovernmental research institute (2,993 replied to this question). "Ever applied for an NIH research grant" is the number of unique individuals who indicated one or more of the following categories: "Ever applied," "Previously PI," and "Currently PI." PI, principal investigator.

Many alumni reported having research support from sources other than the NIH. These data were analyzed in several ways. First, we looked at the funding of the 3,079 alumni who have completed postgraduate training and reported that they are currently employed full-time in academia (3,028) or at research institutes other than the NIH (51). Of these individuals, 1,971 (64.0%) reported being a PI on funded projects from either NIH or non-NIH sources. The results are summarized in Figure 19A. Almost half (965, 48.9%) reported having NIH research grants. Of these, most had research support from other sources as well, but slightly over half of those who were a PI on a funded project (1,006, 51.0%) reported having research support *only* from non-NIH sources.

We looked next at the 1,794 survey respondents working in academia or a research institute other than the NIH who reported that they had never been the PI on an NIH research grant (Figure 19B). Of these 1,794 individuals, 848 (47.3%) reported having current grant support from non-NIH sources. An additional 301 (16.8%) reported having had such support in the past. Figure 20 shows the sources for these non-NIH grants. The largest group was from private foundations. A subset of respondents reported having multiple sources of funds.

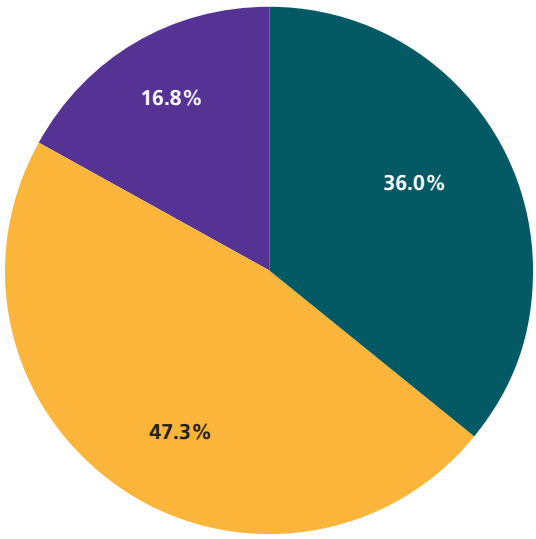
**Figure 19. NIH research grant versus other sources of research funding for select participating program alumni.** **A:** Sources of current research funding for alumni in academia full-time and nongovernmental research institutes. Funding data are for 1,971 alumni who reported currently being a PI on a research grant from the NIH or other funding sources. Note that these numbers include the role of PI but not coinvestigator or other key personnel. **B:** Success at obtaining research funding from non-NIH sources for alumni with no past or current NIH research grant support as a PI. This analysis includes 1,794 alumni who completed postgraduate training, were employed in academia full-time or in nongovernmental research institutes, and do not have either prior or current NIH support as a principal investigator. Total percentages do not add to 100% because of rounding. PI, principal investigator.

A. Current sources of support



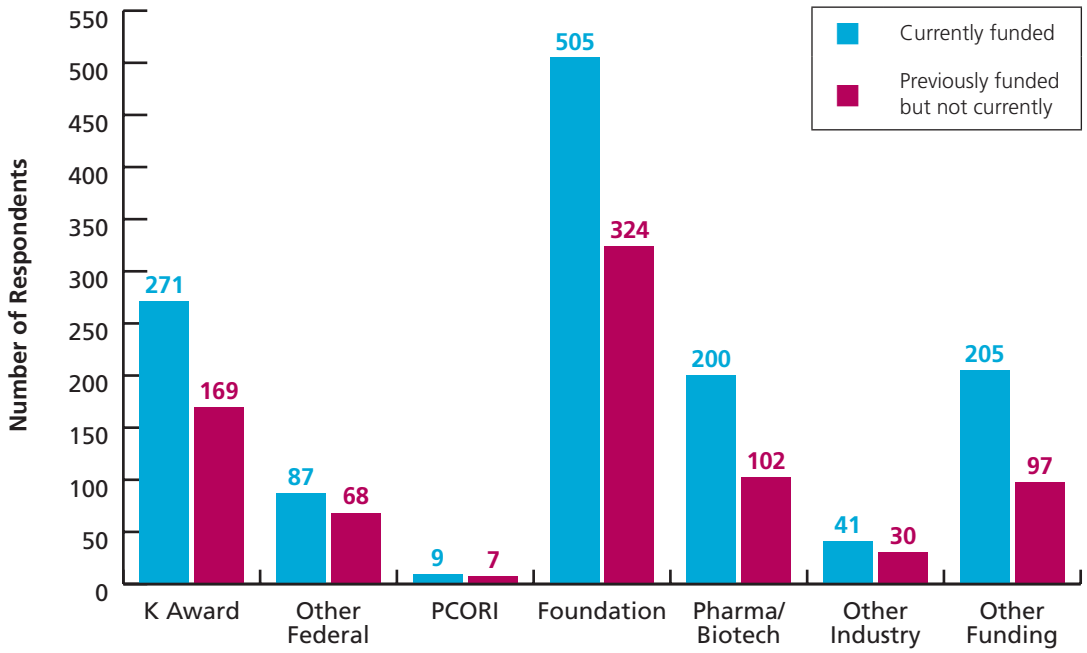

- Only non-NIH research grant funding (no current NIH research grant but a PI on other funding)
- Both (current NIH research grant funding and some other type of funding as a PI)
- Only NIH research grants as current source of support

B. Past and current non-NIH sources of support




- No current or past support as a PI for grant other than an NIH research grant
- Current support as a PI for grant other than an NIH research grant
- Past support as a PI for grant other than an NIH research grant, but no current support as a PI for a grant other than an NIH research grant

**Figure 20. Sources of non-NIH research project grant support for select participating program alumni.** This analysis includes 1,794 alumni who completed postgraduate training and who are employed in academia full-time or at nongovernmental research institutes, who do not have either prior or current NIH research project grant support as a principal investigator (PI). For each funding source, the bars show the number of alumni reporting that they are currently a PI (blue bars) or previously but not currently a PI (red bars). Many respondents had funding from multiple sources. PCORI, Patient-Centered Outcomes Research Institute.




## Leadership Positions and Professional Awards

***Leadership positions.*** Another metric of success in academia is appointment to a significant leadership position. Of the 3,028 alumni currently in academia full-time, 192 (6.3%) reported that they are currently or were previously a department chair, 442 (14.6%) reported that they are currently or were previously a clinical division chief, 203 (6.7%) reported that they are currently an institute or center director, and 70 (2.3%) previously held such a position. Others are, or have served as, dean (12 currently, 5 previously), vice dean (6 currently, 3 previously), associate dean (22 currently, 16 previously), or assistant dean (9 currently, 7 previously).

***Awards and Howard Hughes Medical Institute appointments.*** As a final metric of research success, we asked alumni to tell us whether they had received a Howard Hughes Medical Institute (HHMI) appointment or been elected to the American Society for Clinical Investigation (ASCI), Association of American Physicians (AAP), Institute of Medicine (IOM, now the National Academy of Medicine), or National Academy of Sciences (NAS). Table 7 summarizes the results for alumni through academic year 2003–2004 who responded to the survey.[45] Note that the totals in Table 7 do not reflect the number of unique individuals, taking into account recipients of multiple honors. In general, the awards are more prevalent among the earlier graduation cohorts since those individuals would have had more time in their careers. A substantially higher fraction of men than women were recipient of each of the awards.

## Table 7. Election to Honorary Societies and HHMI Appointments for Select Participating Program Alumni Who Have Completed Graduate Training

| Society or Institute | Total | Percentage of Respondents | Men | | | Women | | |
|---|---|---|---|---|---|---|---|---|
| | | | Number | Percentage | Percentage of Awardees | Number | Percentage | Percentage of Awardees |
| ASCI | 323 | 9.3% | 277 | 10.3% | 85.8% | 46 | 6.1% | 14.2% |
| AAP | 218 | 6.3% | 184 | 6.8% | 84.4% | 34 | 4.5% | 15.6% |
| HHMI | 56 | 1.6% | 50 | 1.9% | 89.3% | 6 | 0.8% | 10.7% |
| IOM | 54 | 1.6% | 49 | 1.8% | 90.7% | 5 | 0.7% | 9.3% |
| NAS | 22 | 0.6% | 21 | 0.8% | 95.5% | 1 | 0.1% | 4.5% |
| Total respondents | 3,457 | — | 2,701 | — | — | 756 | — | — |

Note: Counts only include survey respondents who graduated prior to 2005, because most of the cohort who graduated from academic year 2004–2005 through academic year 2013–2014 are still in training. The right two columns show the percentage of recipients of a given honor who are men or women. ASCI, American Society for Clinical Investigation; AAP, Association of American Physicians; HHMI, Howard Hughes Medical Institute; IOM, Institute of Medicine; NAS, National Academy of Sciences.

# Discussion

MD-PhD programs began in the 1950s on a small scale at a few medical schools. As programs have grown, so have efforts to share best practices. The earliest didactic model, in which graduate school was a disconnected experience planted in the middle of medical school, has been largely replaced with an integrated curriculum that combines medical and graduate training. The initial narrow focus on graduate studies in biomedical laboratory sciences has been broadened to include studies from engineering to the social sciences and economics.[46] Regular external reviews, meetings of program directors, and the reporting requirements for National Institute of General Medical Sciences (NIGMS) Medical Scientist Training Program (MSTP) funding have helped programs focus on the best ways to conduct physician-scientist training while emphasizing the need to track and constantly improve program outcomes. Despite these efforts, concerns have been raised about their effectiveness.[47] This outcomes study was organized in part with those concerns in mind.

## Strengths and Limitations of This Study

The strengths of this study include the support of the leaders of nearly all of the MD-PhD programs, access to AAMC database information on all medical school graduates, and the high percentage (64%) of the 10,591 alumni who took the time to answer the survey. The reader should take into account the following two limitations. The first is our reliance on self-reported survey data for important issues such as the record of each alumnus in applying for and obtaining research support as a PI. A second limitation is that data drawn from the AAMC Faculty Roster show that there are differences between respondents and nonrespondents: 65% of survey respondents were in the AAMC Faculty Roster, but only 45% of the nonrespondents were. There is no certain way to tell at present whether the lower percentage for the nonrespondents is due to an increase in those who are in private practice.[38]

## Study Findings

The results of this study show that a high percentage of MD-PhD program alumni are doing research, obtaining research funding, and following career paths consistent with the goals of their training. Outlined below are the major findings of this study.

***Most MD-PhD program alumni are employed in settings consistent with the goals of their training.*** The survey data show that at least 80% of program graduates who completed the survey are employed in settings consistent with the goals of their dual training. It is also noteworthy that more than 80% of graduates of MD-PhD programs responded that they would definitely or probably repeat the program if they could go back in time. The results of this study are in agreement with several previous single-institution and multi-institution studies.[6-8,20,24-26] Nearly 60% of the program alumni were present in the AAMC Faculty Roster, far more than for medical school graduates in general.[27] In addition, many MD-PhD alumni have taken on significant leadership roles at academic medical centers. Smaller numbers work in the biotech and pharmaceutical industries or research institutes such as the National Institutes of Health (NIH). Comparatively few are in private practice, although as noted above, the 15% of survey respondents who indicated that they are in private practice (Table 2) is highly likely to be an underestimate. Encouragingly, interest in a career in academia does not appear to be fading. Thus, MD-PhD programs have become incubators for future faculty members. A critical issue for sustaining the physician-scientist workforce is how to mentor these trainees to make the transition successfully from postgraduate trainee to independent physician-investigator.

***Most MD-PhD program alumni are doing research.*** Of those who responded to the survey question that asked how professional time is split in their current or most recent position, 77% indicated spending some time doing research. Their accomplishments

have been recognized by election to honorary societies, HHMI appointments, and the award of Nobel Prizes. Their career research interests cover the entire spectrum from basic to patient-oriented research.

***The absence of NIH funding does not equate with the absence of research.*** Although many alumni reported having NIH research grants, 86% of those with funding reported having a mix of funding sources that also includes foundations and industry. Of the 3,079 survey respondents who work either in academia or at a research institute, only 13.5% of those with current research funding receive it solely from the NIH. Nearly half receive their support solely from non-NIH sources. Note that this part of the analysis focused on academia and only includes PIs. Alumni who work at the NIH and other federal agencies or in industry can do research without applying for NIH research grants, and those in the biotech and pharmaceutical industry usually fund their research with corporate resources. Using NIH research grants alone as a surrogate marker for research activity misses a more complex reality in which many graduates obtain research support from multiple sources, especially in an era of declining NIH budgets and funding rates.

***Most MD-PhD program alumni in academia are doing research, but the amount of their time devoted to research varies widely.*** One of the major goals of this study was to find out how MD-PhD program alumni employed in academia apportion their time. Our hypothesis when this study was launched was that research effort would prove to follow a bimodal distribution in which some alumni spent most of their time on research, while others spent little or none. This is not what we found. Instead, the data show that the research effort distribution is largely a continuum, with almost every value for research effort reported. Although only 17% of survey respondents in academia reported devoting ≥80% effort to research, 53% reported ≥50% effort. How they spent their remaining effort varied in a mix of administrative and teaching responsibilities as well as clinical care. We did not ask participants to explain how they arrived at their present distribution of effort. For those with little research effort, is that because they lost interest or had been unable to attract sufficient research funding to justify greater research effort? Is it because they are employed in a department that requires them to help meet clinical service requirements or because the model of a physician-scientist who spends nearly all of her or his time on research has become unrealistic for more than a handful of people? Obtaining the answers to these questions is critical to understanding whether current MD-PhD program graduates will replace the research-intensive older physician-scientist workforce as the physician-scientists retire.

***Trends in GME choices are evolving.*** Graduates of MD-PhD programs have the same options for clinical training as any other medical school graduate. However, historically, they have tended to cluster in fields such as internal medicine, pediatrics, neurology, and pathology.[7,20,48,49] Data published in 2010[7] highlighted a trend in GME choices by MD-PhD program alumni away from internal medicine, pediatrics, neurology, and pathology. There was an increase during the same period in those choosing dermatology, ophthalmology, and radiation oncology. We revisited both of these trends with the much larger 2015 survey dataset. Our findings largely matched those noted previously. The implications of the GME choice for a sustained career in research have been addressed previously.[7] Those data show that MD-PhD program graduates are far more likely to sustain a research program in some clinical fields than in others.

***Time to degree and time to first nontrainee position continues to increase.*** Total training time for MD-PhD program alumni includes the time to obtain both degrees and the time from graduation to a first relatively permanent position. Both time periods are clearly increasing. Time to degree has increased by almost 30% since 1975. The median time to first position has increased from three years or less to up to six years. Note that this time is at least somewhat of an underestimate of time to first assistant professor appointment since we did not ask survey respondents to distinguish between "instructor" and "assistant professor" when they calculated their time to first employment. The drivers for this increase in time are numerous, but likely include increased time for resume building. The net effect has been to create a protracted period in which fully trained physician-

scientists in their mid to late 30s await their first professional-level job.[16] For college students contemplating medical school, a training path this long is doubtlessly daunting. A significant issue is whether it deters people considering applying to MD-PhD programs from pursuing this path to become a physician-scientist.

***Fewer MD-PhD program alumni choose to forgo additional postgraduate clinical training.*** As training takes longer and the burdens of maintaining a medical license and board certification have grown greater, some have predicted that fewer physician-scientists would complete internships and residencies. To date, this does not appear to be the case. Nearly all MD-PhD program alumni choose to do additional postgraduate clinical training. Those who do not have tended to follow a distinct career path in which fewer are entering academia and more are choosing to work in the pharmaceutical and biotech industries. One of the challenges faced by those who do not do postgraduate clinical training is finding a home in a department in which they will not be expected to provide clinical service. This may be one of the drivers for MD-PhD alumni to complete their clinical training and maintain board certification. Other drivers for that decision likely include a desire to participate directly in the care or treatment of people with the diseases that they study and a desire to ensure that they have a meaningful professional alternative should their early success as an investigator falter. It is notable that among the survey respondents, very few who start their career in academia move to private practice, so even if they reduce their research effort, they largely remain in academia.

***The number of MD-PhD program applicants, matriculants, and graduates has increased but remains smaller than projected workforce needs.*** In 2016 there were 1,936 MD-PhD program applicants, 649 matriculants, and 602 graduates.[9-11] This number of graduates is just over half the number that the PSW report estimated will be needed to sustain the workforce at current levels. In contrast, the number of medical school graduates in 2016 was 18,938.[12]

***MD-PhD training programs are moving toward greater diversity, but more work is needed to increase the diversity of MD-PhDs.*** The PSW report noted a lack of diversity in the U.S. physician-scientist workforce.[4] We found evidence of recent improvement, yet despite efforts within the medical school community[50] and requirements from the NIH to develop plans to enhance diversity, achieving sex, racial, and ethnic diversity remains a challenge. According to our research, racial and ethnic groups previously shown to be underrepresented continue to be underrepresented in the applicant pool for MD-PhD programs. Many reasons have been cited for this, including the lack of role models on medical school faculties, the lack of undergraduate research opportunities, and insufficient advising before medical school. Institutions must create an environment that is welcoming to and inclusive of diverse learners, faculty, and staff, including those with disabilities.[51]

We find it especially noteworthy that despite the fact that women represent almost half of the students in medical school, only 35%–40% of individuals who combine the MD and PhD are women.[32] Racial and ethnic diversity of MD-PhD programs also lags behind that of their diversity in medical school enrollment. We note in this regard the longstanding efforts by the NIH and by the AAMC Group on Graduate Research, Education, and Training (GREAT) MD-PhD Section, especially the Communication Committee, to educate college and high school students and their parents and advisors about the physician-scientist career path.[52] We also note the appearance of studies that highlight disparities, including a recent report showing large differences in salaries and startup packages awarded to men versus to women.[53,54]

***Both similarities and differences exist for men and women graduates.*** From the outset, there have been far more men than women in MD-PhD training programs. This gap has closed somewhat but remains a challenge. Among survey respondents, we found no differences between men and women in their first workplace, current workplace, or expected workplace. There was also little difference of note in the GME choices made by men and women. However, a greater percentage of men than women were found in the AAMC Faculty Roster, especially among those who did not respond to the survey. While 48% of the men who did not complete the survey have ever been full-time faculty members at U.S. medical schools, only 38% of the women who did

not complete the survey have ever been full-time faculty members at U.S. medical schools. Women are also less well represented on the list of award recipients and honorees. Determining whether there are racial and ethnic differences in career outcomes of MD-PhD program graduates is an area for future research.

## Opportunities

The lessons learned from this study suggest at least four opportunities to address issues raised by the data.

The first is to consider what has been learned about the MD-PhD program graduate career path and do as much as possible to make students better prepared for the inherent challenges ahead. That might include preparing them to pursue research in directions that include translational and patient-oriented inquiries as well as basic science. It would also include helping them develop skills as collaborators as well as research team leaders and helping them begin to acquire the skills needed to compete successfully for research funds from the NIH and from other sources as well. We expect that improving the preparation would be beneficial for all physician-scientists, not only MD-PhD program graduates. The community must also consider ways to increase the diversity of the physician-scientist workforce.

The second opportunity is to bring new MD-PhD trainees into the world of biomedical discovery as early as possible and then maintain their connection to research throughout their training. This means avoiding placing future physician-scientists in silos in which they spend extended periods of years totally divorced from the world of research. It also means a national effort to rethink residency training, creating more physician-scientist pathway residencies that really do permit research to continue.

The third opportunity is to help MD-PhD students find the information they need to make informed choices, guiding them to consider clinical fields and clinical training programs that support a culture of research engagement. Graduating students will continue to pick clinical fields based on a range of personal and professional priorities. It is up to program leaders to help them prepare for the challenges that will arise from their choices. Such programs must be created in a wider range of clinical specialties.

The final opportunity is to shorten the time it takes to achieve an independent career by reducing both the time to degree and the time for postgraduate training, which in aggregate have nearly doubled since MD-PhD training programs were established. We completely agree with the members of the PSW advisory group and others that this is a problem requiring attention.[4,16] The challenge is to do so while maintaining quality, but in view of the accomplishments of the early program graduates who completed training when the path to independence was shorter, this should be achievable.

## Conclusions

Almost 80% of MD-PhD program alumni survey respondents are employed in workplaces where they can do research, develop new devices and therapies, improve public health, and help to train the next generation of scientists, physician-scientists, and clinicians. Their job mix varies, but on the whole it reflects the activities for which they were trained and responsibilities that they have been collectively asked to shoulder. Although not every applicant who enters an MD-PhD program in their early 20s remains on the path to becoming a physician-scientist, many of them do. However, the data, such as those included in the PSW report, also show that the current number of MD-PhD program graduates per year will not meet expected workforce needs, that the number of applicants per year has been insufficient to fuel substantial additional growth in program size, and that there is a need to focus on increasing diversity among MD-PhDs. As a result, other approaches to training physician-scientists have been and will continue to be required, as will measures to limit leaving the physician-scientist career path after medical school.

# Appendix A
# Survey: MD-PhD Program Graduates Career Outcomes

This is the survey instrument administered to MD-PhD program alumni as part of this study.

AAMC

Tomorrow's Doctors, Tomorrow's Cures

## MD-PhD Program Graduates Career Outcomes

**The purpose of this study is to understand MD-PhD workforce career trajectories and to define the broad spectrum of "career successes"; to inform and facilitate MSTP grant application / renewals and institutional program support and funding; and to inform national policies on physician-scientist training by collecting outcome data on MD-PhD program graduates.**

**You are invited to participate because you have completed the MD-PhD dual degree program. All MD-PhD dual degree program graduates with known electronic mail addresses are invited to participate in the study.**

**If you choose to participate, you will be asked to complete a short survey that should not take more than 10-15 minutes of your time. Your participation in this survey will be greatly appreciated and will allow us to learn more about career choices and outcomes of program graduates. With your permission, your program director and administrator will have access to your identifiable individual responses. Otherwise, your data will not be released outside the AAMC, except with your written permission - the researchers will keep your information confidential. The data will be reviewed, analyzed, presented, and/or published in aggregated format only.**

**There are no personal benefits from participating in this survey. MD-PhD training programs may benefit from learning about MD-PhD workforce career trajectories and will be able to better define the broad spectrum of "career successes." These data may inform and facilitate MSTP grant application / renewals and institutional program support and funding. The only foreseeable risk associated with participation in this survey is the imposition on the participant's time.**

**If you have any concerns about the risks or benefits of participating in this survey, you can contact Irena Tartakovsky at itartakovsky@aamc.org, or the Human Subjects Protection Program at hsrppadministrator@aamc.org.**

**There are no costs to you or monetary compensation for participating in this study. The IRB and other government agencies may request to review survey results.**

**You have the right to refuse to participate in this survey at no penalty to you. You are free to withdraw your participation from this survey at any time. If you do not want to participate at all, you can simply leave this website now. If during the survey you do not wish to continue, please leave the survey at any point. If you are unable or not willing to answer any particular question, you are allowed to move to the next question. If you choose to stop completing the survey before clicking "Submit", your data will not be included in analysis.**

**Voluntary Consent by Participant:**

○ I have read and fully understand the contents of preceding consent form and voluntarily consent to participate in this survey
○ I decline

---

**I grant permission to researchers to share my responses with the program from which I graduated**

○ Yes
○ No

1. **Please enter your name:**

First Name
Middle Name
Last Name

2. **Have you changed your name since starting medical school?**

○ Yes
○ No

2a. **If you have changed your name since starting medical school, tell us what was your name when you were in the MD-PhD training program?**

First Name
Last Name

3. **What is your current employment status?**

- ○ Employed full time
- ○ Employed part time
- ○ Employment hiatus (please answer subsequent questions relative to your last place of employment)
- ○ Retired (please answer subsequent questions relative to your last place of employment)

4. **Where do you currently work?**

Organization / Practice name:
City:
State or Province:
Zip code:
If outside of US or Canada, please specify:

5. **Are you currently in postgraduate training (i.e., resident, fellow, post-doc)?**

- ○ Yes
- ○ No

5a. **In what medical specialty is your postgraduate training (i.e., residency, fellowship, post-doc)?**

- ☐ Allergy and Immunology
- ☐ Anesthesiology
- ☐ Colon and Rectal Surgery
- ☐ Dermatology
- ☐ Emergency Medicine
- ☐ Family Medicine
- ☐ Internal Medicine, please specify if Sub-Specialty
- ☐ Medical Genetics
- ☐ Neurological Surgery
- ☐ Neurology
- ☐ Nuclear Medicine
- ☐ Obstetrics and Gynecology
- ☐ Ophthalmology
- ☐ Orthopedic Surgery
- ☐ Otolaryngology
- ☐ Pain Medicine
- ☐ Pathology, please specify if Sub-Specialty
- ☐ Pediatrics, please specify if Sub-Specialty
- ☐ Pediatric Neurology
- ☐ Physical Medicine and Rehabilitation
- ☐ Plastic Surgery
- ☐ Preventive Medicine
- ☐ Psychiatry
- ☐ Radiology - Diagnostic

☐ Radiation Oncology
☐ Surgery - General
☐ Vascular Surgery
☐ Thoracic and Cardiac Surgery
☐ Urology
☐ Combined Specialties, please specify: _____
☐ Other, please specify: _____

5b. **When you complete your postgraduate training do you expect to start a position in (choose one):**

○ Academia full time
○ Academia part time
○ NIH
○ Federal agency other than the NIH, please specify: _____
○ Research institute (non-federal), please specify: _____
○ Pharmaceutical/biotech industry
○ Non-academic clinical practice
○ Consulting/Law/Finance
○ Other, please specify: _____

6. **In what medical specialty did you obtain postgraduate training (i.e., resident, fellow, post-doc)?**

☐ Did not do postgraduate clinical training Please indicate the area of postgraduate fellowship/training: _____
☐ Allergy and Immunology
☐ Anesthesiology
☐ Colon and Rectal Surgery
☐ Dermatology
☐ Emergency Medicine
☐ Family Medicine
☐ Internal Medicine, please specify if Sub-Specialty: _____
☐ Medical Genetics
☐ Neurological Surgery
☐ Neurology
☐ Nuclear Medicine
☐ Obstetrics and Gynecology
☐ Ophthalmology
☐ Orthopedic Surgery
☐ Otolaryngology
☐ Pain Medicine
☐ Pathology, please specify if Sub-Specialty: _____
☐ Pediatrics, please specify if Sub-Specialty: _____
☐ Pediatric Neurology
☐ Physical Medicine and Rehabilitation
☐ Plastic Surgery
☐ Preventive Medicine
☐ Psychiatry
☐ Radiology - Diagnostic
☐ Radiation Oncology
☐ Surgery - General

☐ Vascular Surgery
☐ Thoracic and Cardiac Surgery
☐ Urology
☐ Combined Specialties, please specify:
☐ Other, please specify:

7. **How many years passed between your MD-PhD graduation and your first appointment to a full time position after residency/fellowship/postdoc as a physician and/or scientist?**

○ 3 or less
○ 4
○ 5
○ 6
○ 7
○ 8
○ 9
○ 10 or more
○ Not yet in a full time position

8. **Which of the following best describes your first position after you completed all of your postgraduate training?**

○ Academia full time
○ Academia part time
○ NIH
○ Federal agency other than the NIH, please specify:
○ Research institute (non-federal), please specify:
○ Pharmaceutical/biotech industry
○ Non-academic clinical practice
○ Consulting/Law/Finance
○ Other, please specify:

9. **Were you, at any point in your career, Board Certified by the American Board of Medical Specialties (ABMS)?**
**Your response to this question will not be shared with the program from which you graduated, and will be only used in aggregate data analysis.**

○ Yes
○ No

9a. **Are you maintaining active ABMS Certification in at least one specialty at the present time?**
**Your response to this question will not be shared with the program from which you graduated, and will be only used in aggregate data analysis.**

○ Yes
○ No

9b. **If you are not maintaining active ABMS Certification at the present time, please tell us why?**
**Your response to this question will not be shared with the program from which you graduated, and will be only used in aggregate data analysis.**

**10. Which of the following best describes your current position (or last position if you are currently between jobs or retired)? Choose one:**

- ○ Academia full time
- ○ Academia part time
- ○ NIH
- ○ Federal agency other than the NIH, please specify: [ ]
- ○ Research institute (non-federal), please specify: [ ]
- ○ Pharmaceutical/biotech industry
- ○ Non-academic clinical practice
- ○ Consulting/Law/Finance
- ○ Other, please specify: [ ]

**10a. If you are in academia, what is your current academic rank?**

- ○ Instructor
- ○ Assistant Professor
- ○ Associate Professor
- ○ Professor
- ○ Other, please specify: [ ]

**10b. If your primary position is not in academia, are you affiliated with academia and if so, in what rank? Please specify your affiliation type (e.g. research, adjunct, visiting, etc.)?**

- ○ Not affiliated
- ○ Assistant Professor, please specify affiliation type: [ ]
- ○ Associate Professor, please specify affiliation type: [ ]
- ○ Professor, please specify affiliation type: [ ]
- ○ Other, please specify: [ ]

**11. Please check any of the following administrative positions that you have previously held or currently hold:**

| | Currently | Previously |
|---|---|---|
| Dean | ☐ | ☐ |
| Vice Dean | ☐ | ☐ |
| Associate Dean | ☐ | ☐ |
| Assistant Dean | ☐ | ☐ |
| Department Chair | ☐ | ☐ |
| Vice Chair | ☐ | ☐ |
| Vice Chair or Director for Research | ☐ | ☐ |
| Clinical Division Chief | ☐ | ☐ |
| Training Program Director | ☐ | ☐ |
| Institute/Center Director | ☐ | ☐ |
| Branch/Section Chief | ☐ | ☐ |
| Chief Scientific Officer | ☐ | ☐ |
| Chief Medical Officer | ☐ | ☐ |
| Chief Operating Officer | ☐ | ☐ |
| Vice President | ☐ | ☐ |
| CEO | ☐ | ☐ |

11a. **Other administrative position(s), please specify:**

Currently: _____

Previously: _____

12. **How do you split your professional time in your current or most recent position?**

| | |
|---|---|
| Research | % |
| Clinical care at an academic medical center | % |
| Non-academic clinical practice | % |
| Teaching* | % |
| Administration | % |
| Consulting | % |
| Other (please specify below) | % |
| Total | % |

If you chose "Other" in the question above, please specify: _____

*** Teaching includes, classroom lectures, small group preceptorships and clinical teaching on the wards. Include time spent teaching students and postdocs in your laboratory as research time.**

13. **Which of the following best describes the type of research you do? Check all that apply:**

- ☐ Basic Science[1]
- ☐ Translational[2]
- ☐ Patient-Oriented (POR)[3]
- ☐ Health Services[4]
- ☐ Other, please specify: _____

**[1]Basic science is defined as fundamental theoretical or experimental investigative research to advance knowledge without a specifically envisaged or immediately practical application. It is the quest for new knowledge and the exploration of the unknown (http://www.icsu.org/publications/icsu-position-statements/value-scientific-research/the-value-of-basic-scientific-research-dec-2004).**

**[2]Translational research, the process of applying ideas, insights, and discoveries generated through basic scientific inquiry to the treatment or prevention of human disease (from NIH- PAR-02-138).**

**[3]Including clinical trials**

**[4]Including health disparities/inequities, health outcomes, behavioral interventions, community participatory research, and health services research**

14. **Following completion of your MD-PhD Degree, have you ever received research funding of any kind?**

- ○ Yes
- ○ No

15. **Please indicate all research funding you received following completion of your MD-PhD degree. Check all that apply:**

| | Did you ever apply as a PI for: | I am Currently funded as PI | I was Previously funded as PI | I am currently a research team member other than PI | I was previously a research team member other than PI |
|---|---|---|---|---|---|
| NIH (mentored career development awards)[1] | ☐ | ☐ | ☐ | ☐ | ☐ |
| NIH Research grants[2] | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other Federal grants[3] | ☐ | ☐ | ☐ | ☐ | ☐ |
| PCORI, AHRQ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Private Foundation[4] | ☐ | ☐ | ☐ | ☐ | ☐ |
| Pharma / Biotech | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other Industry | ☐ | ☐ | ☐ | ☐ | ☐ |

[1]**K awards**
[2]**R01, R21, P01, U54, etc.**
[3]**NSF, DOD, VA, NASA, CDC, DARPA, ONR, FDA, etc.**
[4]**AHA, ACS, CFF, etc., including both mentored and independent research and career development awards**

15a. **If you received funding from any sources not indicated above, please list them below on the right and check all that apply:**

| | Please name the funding source | Other funding | | | |
|---|---|---|---|---|---|
| | | I am Currently funded as PI | I was Previously funded as PI | I am currently a research team member other than PI | I was previously a research team member other than PI |
| 1 | | ☐ | ☐ | ☐ | ☐ |
| 2 | | ☐ | ☐ | ☐ | ☐ |
| 3 | | ☐ | ☐ | ☐ | ☐ |

16. **Please enter your NIH eRA Commons username (if you have one).**
***This information will make it easier to search NIH public databases. We do NOT want your password!***

17. **If you could go back in time, would you opt again for MD-PhD training? (choose one)**
**Your response to this question will not be shared with the program from which you graduated, and will be only used in aggregate data analysis.**

- ○ Definitely yes
- ○ Probably yes
- ○ Uncertain
- ○ Probably no
- ○ Definitely no

18 **Please indicate whether you have been elected or chosen for each of the following (indicate all that apply):**

- ☐ ASCI
- ☐ AAP
- ☐ HHMI
- ☐ IOM
- ☐ NAS
- ☐ Other major national or international awards (received after MD-PhD program graduation). Please specify: [ ]

19. **Do you hold any patents (issued or pending)?**

- ○ Yes
- ○ No

19a. **How many patents?**

Please enter number of patents: [ ]

20. **Please indicate the total number of publications (including peer-reviewed / reviews / book chapters but not abstracts) you have published?**

Please enter number of publications: [ ]

**PLEASE SEND YOUR CURRENT COMPLETE CV (NOT NIH BIOSKETCH) TO mdphdsurvcv@aamc.org**

**Thank you for completing this survey.**

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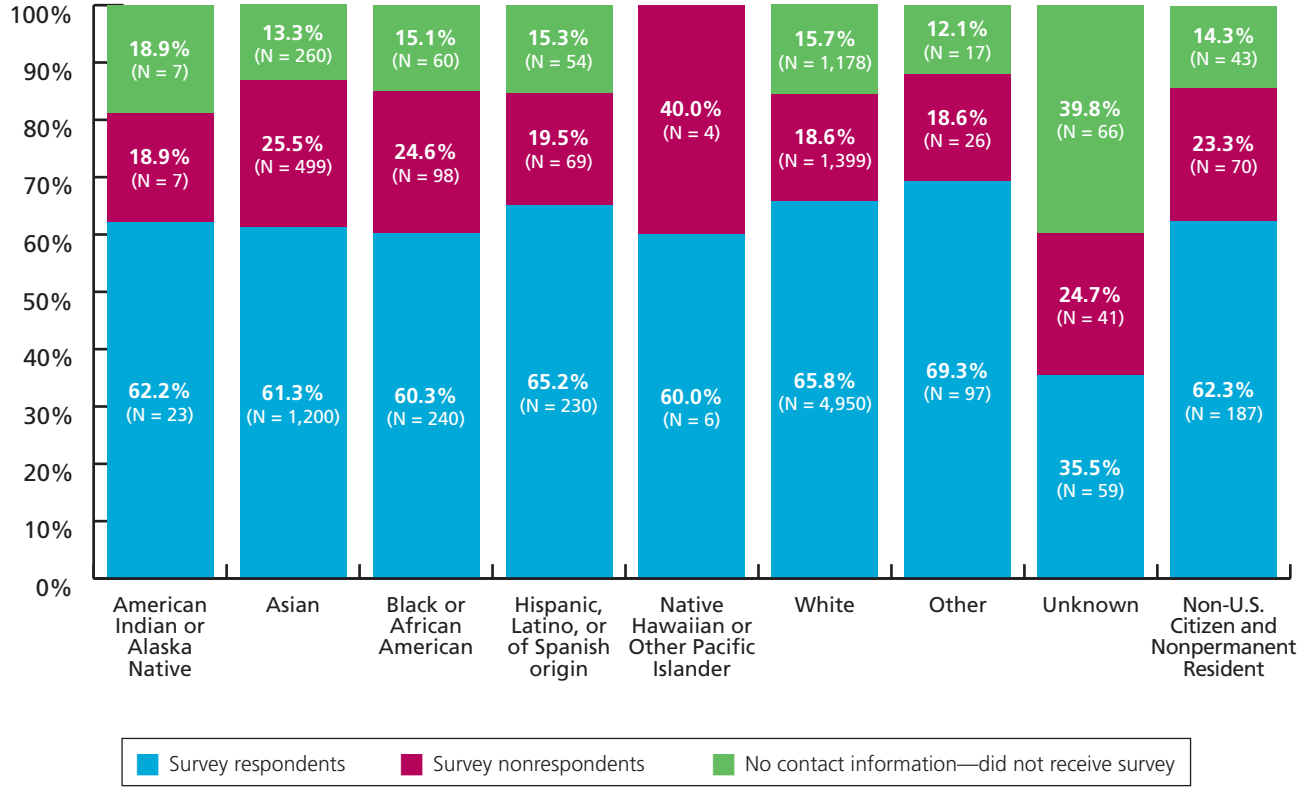
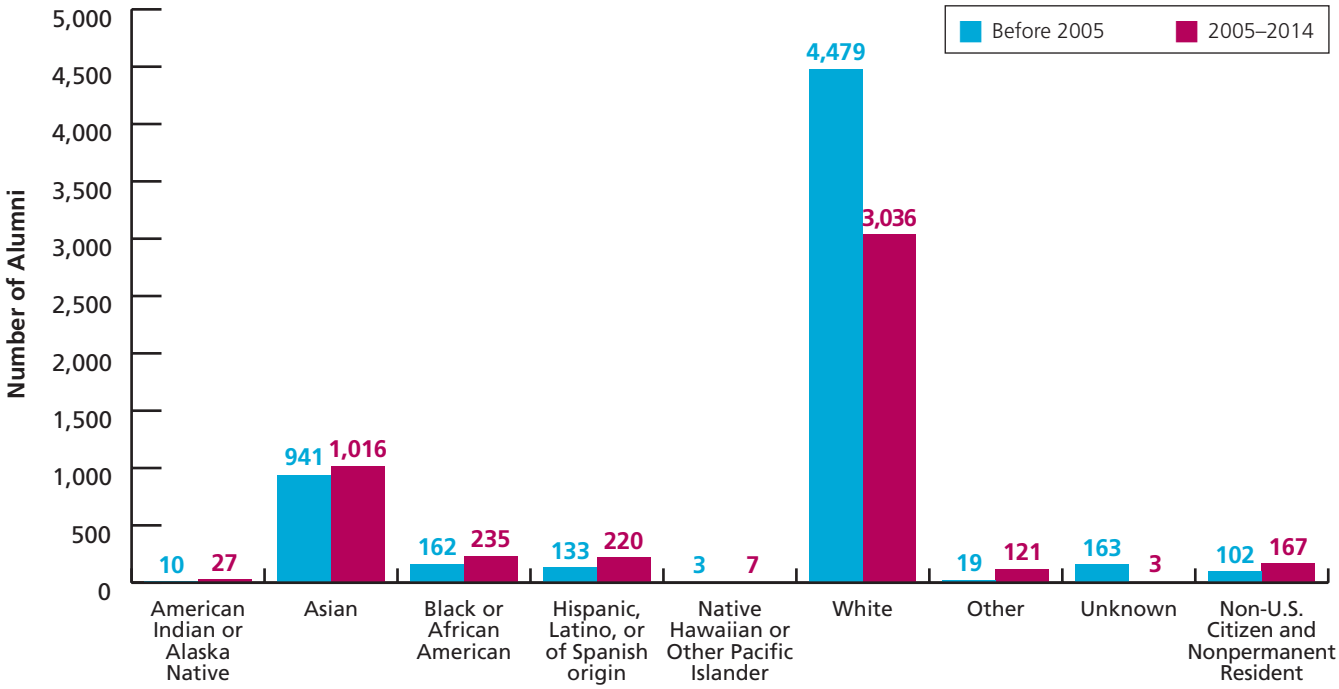
# Appendix B
# Supplemental Figures

**Supplemental Figure 1. Distribution of survey respondents and nonrespondents by race and ethnicity.**
Percentage of each racial and ethnic group among 6,785 survey respondents, 2,155 nonrespondents, and 1,645 MD-PhD program alumni for whom programs lacked email addresses. Individuals for whom citizenship information was not available from the AAMC Student Records System (SRS) were excluded.



**Supplemental Figure 2. Race and ethnicity of all participating program alumni.** This figure presents the data that are in Table 1.



# Appendix C
# Supplemental Tables

### Supplemental Table 1. Participating MD-PhD Programs

Albert Einstein College of Medicine
Baylor College of Medicine
Case Western Reserve University School of Medicine
Columbia University Vagelos College of Physicians and Surgeons
Drexel University College of Medicine
Duke University School of Medicine
Emory University School of Medicine
Geisel School of Medicine at Dartmouth
Harvard Medical School
Icahn School of Medicine at Mount Sinai
Indiana University School of Medicine
Jacobs School of Medicine and Biomedical Sciences at the University at Buffalo
Johns Hopkins University School of Medicine
Keck School of Medicine of the University of Southern California
Lewis Katz School of Medicine at Temple University
Loma Linda University School of Medicine
Louisiana State University School of Medicine in New Orleans
Loyola University Chicago, Stritch School of Medicine
Mayo Clinic School of Medicine
McGovern Medical School at the University of Texas Health Science Center at Houston
Medical College of Wisconsin
Medical University of South Carolina College of Medicine
Michigan State University College of Human Medicine
New York University School of Medicine
Northwestern University The Feinberg School of Medicine
Ohio State University College of Medicine
Oregon Health & Science University School of Medicine
Pennsylvania State University College of Medicine
Perelman School of Medicine at the University of Pennsylvania
Rutgers New Jersey Medical School
Rutgers, Robert Wood Johnson Medical School
Saint Louis University School of Medicine
Sidney Kimmel Medical College at Thomas Jefferson University
State University of New York Downstate Medical Center College of Medicine
State University of New York Upstate Medical University
Stony Brook University School of Medicine
Texas A&M Health Science Center College of Medicine
The Warren Alpert Medical School of Brown University
Tufts University School of Medicine
University of Alabama School of Medicine
University of Arizona College of Medicine
University of Arkansas for Medical Sciences College of Medicine
University of California, Davis, School of Medicine
University of California, Irvine, School of Medicine
University of California, Los Angeles, David Geffen School of Medicine
University of California, San Diego, School of Medicine
University of California, San Francisco, School of Medicine
University of Chicago Division of the Biological Sciences The Pritzker School of Medicine
University of Cincinnati College of Medicine
University of Colorado School of Medicine
University of Connecticut School of Medicine
University of Illinois College of Medicine
University of Iowa Roy J. and Lucille A. Carver College of Medicine
University of Kansas School of Medicine
University of Kentucky College of Medicine
University of Louisville School of Medicine
University of Maryland School of Medicine
University of Massachusetts Medical School
University of Miami Leonard M. Miller School of Medicine
University of Michigan Medical School
University of Minnesota Medical School
University of Mississippi School of Medicine
University of Nebraska College of Medicine
University of North Carolina at Chapel Hill School of Medicine
University of Oklahoma College of Medicine
University of Pittsburgh School of Medicine
University of Rochester School of Medicine and Dentistry
University of Texas Health Science Center at San Antonio Long School of Medicine
University of Texas Southwestern Medical Center Southwestern Medical School
University of Utah School of Medicine
University of Virginia School of Medicine
University of Washington School of Medicine
University of Wisconsin School of Medicine and Public Health
Vanderbilt University School of Medicine
Virginia Commonwealth University School of Medicine
Washington University School of Medicine in St. Louis
Wayne State University School of Medicine
Weill Cornell Medicine
West Virginia University School of Medicine
Yale School of Medicine

Note: The 80 participating programs include 44 of the 45 programs that held National Institute of General Medical Sciences Medical Scientist Training Program T32 grants in 2014.

## Supplemental Table 2. Survey Response Rates by Academic Year of Medical School Graduation and Sex

| Category | Before 1975 | 1975–1984 | 1985–1994 | 1995–2004 | 2005–2014 | All years |
|---|---|---|---|---|---|---|
| Total MD-PhD Alumni | 159 | 922 | 1,742 | 3,163 | 4,548 | 10,567 |
| Survey Respondents | 79 | 526 | 1,000 | 1,852 | 3,303 | 6,777 |
| Percentage of Survey Respondents | 49.7% | 57.0% | 57.4% | 58.6% | 72.6% | 64.1% |
| Total MD-PhD Alumni: Men | 157 | 821 | 1,429 | 2,300 | 2,947 | 7,680 |
| Total MD-PhD Alumni: Women | 2 | 101 | 313 | 863 | 1,601 | 2,887 |
| Total MD-PhD Alumni: Percentage of Women | 1.3% | 11.0% | 18.0% | 27.3% | 35.2% | 27.3% |
| Survey Respondents: Men | 78 | 470 | 819 | 1,334 | 2,165 | 4,879 |
| Survey Respondents: Women | 1 | 56 | 181 | 518 | 1,138 | 1,898 |
| Survey Respondents: Percentage of Women | 1.3% | 10.6% | 18.1% | 28.0% | 34.5% | 28.0% |

Note: Data from this table are presented in Figure 3. The 24 alumni for whom sex data was not available in the AAMC Student Records System (SRS) and other AAMC databases are not included in this table.

## Supplemental Table 3. Participating Program Alumni Listed in the AAMC Faculty Roster

| Category | Total | Men | Women |
|---|---|---|---|
| Total out of training | 8,276 | 6,269 | 2,007 |
| Total out of training in FR database | 4,783 | 3,743 | 1,040 |
| Percentage out of training in FR database | 57.8% | 59.7% | 51.8% |
| | | | |
| Total survey respondents | 5,053 | 3,800 | 1,253 |
| Total nonrespondents | 3,223 | 2,469 | 754 |
| | | | |
| Survey respondents in FR database | 3,323 | 2,570 | 753 |
| Percentage of respondents in FR database | 65.8% | 67.6% | 60.1% |
| Nonrespondents in FR database | 1,460 | 1,173 | 287 |
| Percentage of nonrespondents in FR database | 45.3% | 47.5% | 38.1% |

Note: The AAMC Faculty Roster was scanned for 8,276 program alumni who were not listed in GME Track® as actively training in 2014. The table breaks these numbers down by sex and participation in the survey. Data from this table are presented in Figure 5. FR, Faculty Roster.

## Supplemental Table 4. First Workplace Reported by Academic Year of Medical School Graduation and Sex

| | Men | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | All Years | |
| Workplace | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 48 | 61.5% | 373 | 80.4% | 642 | 78.7% | 948 | 71.8% | 603 | 71.3% | 2,619 | 74.1% |
| Academia part-time | 2 | 2.6% | 12 | 2.6% | 22 | 2.7% | 37 | 2.8% | 18 | 2.1% | 92 | 2.6% |
| NIH | 10 | 12.8% | 31 | 6.7% | 32 | 3.9% | 18 | 1.4% | 6 | 0.7% | 100 | 2.8% |
| Federal agency | 3 | 3.8% | 12 | 2.6% | 13 | 1.6% | 13 | 1.0% | 10 | 1.2% | 52 | 1.5% |
| Research institute | 0 | 0.0% | 7 | 1.5% | 7 | 0.9% | 8 | 0.6% | 4 | 0.5% | 26 | 0.7% |
| Industry | 2 | 2.6% | 5 | 1.1% | 24 | 2.9% | 47 | 3.6% | 29 | 3.4% | 107 | 3.0% |
| Private practice | 11 | 14.1% | 18 | 3.9% | 60 | 7.4% | 202 | 15.3% | 135 | 16.0% | 426 | 12.1% |
| Consulting/law/ finance | 0 | 0.0% | 0 | 0.0% | 2 | 0.2% | 9 | 0.7% | 13 | 1.5% | 24 | 0.7% |
| Other | 2 | 2.6% | 6 | 1.3% | 14 | 1.7% | 39 | 3.0% | 28 | 3.3% | 89 | 2.5% |
| Total | 78 | 100.0% | 464 | 100.0% | 816 | 100.0% | 1,321 | 100.0% | 846 | 100.0% | 3,535 | 100.0% |

| | Women | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | All Years | |
| Workplace | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 0 | 0.0% | 40 | 72.7% | 133 | 73.90% | 352 | 69.2% | 222 | 63.4% | 748 | 68.2% |
| Academia part-time | 0 | 0.0% | 2 | 3.6% | 7 | 3.90% | 25 | 4.9% | 18 | 5.1% | 52 | 4.7% |
| NIH | 1 | 100.0% | 4 | 7.3% | 3 | 1.70% | 7 | 1.4% | 1 | 0.3% | 16 | 1.5% |
| Federal agency | 0 | 0.0% | 2 | 3.6% | 1 | 0.60% | 12 | 2.4% | 5 | 1.4% | 20 | 1.8% |
| Research institute | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 6 | 1.2% | 2 | 0.6% | 8 | 0.7% |
| Industry | 0 | 0.0% | 4 | 7.3% | 4 | 2.20% | 14 | 2.8% | 12 | 3.4% | 34 | 3.1% |
| Private practice | 0 | 0.0% | 3 | 5.5% | 21 | 11.70% | 73 | 14.3% | 69 | 19.7% | 167 | 15.2% |
| Consulting/law/ finance | 0 | 0.0% | 0 | 0.0% | 2 | 1.10% | 1 | 0.2% | 3 | 0.9% | 6 | 0.5% |
| Other | 0 | 0.0% | 0 | 0.0% | 9 | 5.00% | 19 | 3.7% | 18 | 5.1% | 46 | 4.2% |
| Total | 1 | 100.0% | 55 | 100.0% | 180 | 100.0% | 509 | 100.0% | 350 | 100.0% | 1,097 | 100.0% |

Note: Number and percentage of alumni in each graduation cohort with their first position in the indicated category. Survey responses obtained from 3,535 men and 1,097 women. Data are presented in Figures 6A and 6B. Nine survey respondents for whom sex data are not available are excluded from the table. Additionally, medical school graduation dates were not available for 23 survey respondents. Therefore, the sum of the rows may not equal the totals presented in the "All Years" column.

## Supplemental Table 5. Current Workplace Reported by Academic Year of Medical School Graduation and Sex

| | Men | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | All Years | |
| Workplace | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 34 | 43.6% | 288 | 62.1% | 547 | 67.0% | 871 | 65.7% | 585 | 69.1% | 2,331 | 65.8% |
| Academia part-time | 7 | 9% | 18 | 3.9% | 17 | 2.1% | 34 | 2.6% | 18 | 2.1% | 97 | 2.7% |
| NIH | 4 | 5.1% | 20 | 4.3% | 25 | 3.1% | 16 | 1.2% | 4 | 0.5% | 70 | 2.0% |
| Federal agency | 4 | 5.1% | 11 | 2.4% | 20 | 2.4% | 20 | 1.5% | 13 | 1.5% | 68 | 1.9% |
| Research institute | 1 | 1.3% | 9 | 1.9% | 8 | 1.0% | 17 | 1.3% | 3 | 0.4% | 38 | 1.1% |
| Industry | 3 | 3.8% | 38 | 8.2% | 74 | 9.1% | 98 | 7.4% | 40 | 4.7% | 254 | 7.2% |
| Private practice | 19 | 24.4% | 45 | 9.7% | 90 | 11.0% | 211 | 15.9% | 139 | 16.4% | 504 | 14.2% |
| Consulting/law/ finance | 1 | 1.3% | 10 | 2.2% | 3 | 0.4% | 7 | 0.5% | 11 | 1.3% | 32 | 0.9% |
| Other | 5 | 6.4% | 25 | 5.4% | 33 | 4.0% | 51 | 3.8% | 34 | 4.0% | 148 | 4.2% |
| Total | 78 | 100.0% | 464 | 100.0% | 817 | 100.0% | 1,325 | 100.0% | 847 | 100.0% | 3,542 | 100.0% |

| | Women | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | All Years | |
| Workplace | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 1 | 100.0% | 36 | 64.3% | 117 | 65.4% | 323 | 63.1% | 217 | 61.5% | 694 | 62.9% |
| Academia part-time | 0 | 0.0% | 2 | 3.6% | 3 | 1.7% | 25 | 4.9% | 16 | 4.5% | 46 | 4.2% |
| NIH | 0 | 0.0% | 4 | 7.1% | 6 | 3.4% | 8 | 1.6% | 1 | 0.3% | 19 | 1.7% |
| Federal agency | 0 | 0.0% | 0 | 0.0% | 3 | 1.7% | 8 | 1.6% | 9 | 2.5% | 20 | 1.8% |
| Research institute | 0 | 0.0% | 1 | 1.8% | 1 | 0.6% | 9 | 1.8% | 2 | 0.6% | 13 | 1.2% |
| Industry | 0 | 0.0% | 4 | 7.1% | 10 | 5.6% | 28 | 5.5% | 14 | 4.0% | 56 | 5.1% |
| Private practice | 0 | 0.0% | 5 | 8.9% | 24 | 13.4% | 77 | 15.0% | 69 | 19.5% | 177 | 16.0% |
| Consulting/law/ finance | 0 | 0.0% | 2 | 3.6% | 3 | 1.7% | 1 | 0.2% | 3 | 0.8% | 9 | 0.8% |
| Other | 0 | 0.0% | 2 | 3.6% | 12 | 6.7% | 33 | 6.4% | 22 | 6.2% | 69 | 6.3% |
| Total | 1 | 100.0% | 56 | 100.0% | 179 | 100.0% | 512 | 100.0% | 353 | 100.0% | 1,103 | 100.0% |

Note: Number and percentage of alumni in each graduation cohort with their current position in the indicated category. Survey responses obtained by 3,542 men and 1,103 women. Data are presented in Figures 6C and 6D. Nine survey respondents for whom sex data are not available are excluded from the table. Additionally, medical school graduation dates were not available for 23 survey respondents. Therefore, the sum of the rows may not equal the totals presented in the "All Years" column.

## Supplemental Table 6. First Workplace Reported by Participants Who Did Not Complete Residency Training by Academic Year of Medical School Graduation

| | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | All Years | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Workplace | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Academia full-time | 8 | 80.0% | 40 | 83.3% | 68 | 73.9% | 77 | 68.1% | 43 | 46.7% | 236 | 66.3% |
| Academia part-time | 0 | 0.0% | 0 | 0.0% | 2 | 2.2% | 2 | 1.8% | 4 | 4.3% | 9 | 2.5% |
| NIH | 1 | 10.0% | 2 | 4.2% | 2 | 2.2% | 2 | 1.8% | 1 | 1.1% | 8 | 2.2% |
| Federal agency | 0 | 0.0% | 0 | 0.0% | 2 | 2.2% | 2 | 1.8% | 1 | 1.1% | 5 | 1.4% |
| Research institute | 0 | 0.0% | 4 | 8.3% | 3 | 3.3% | 1 | 0.9% | 2 | 2.2% | 10 | 2.8% |
| Industry | 1 | 10.0% | 2 | 4.2% | 8 | 8.7% | 13 | 11.5% | 16 | 17.4% | 40 | 11.2% |
| Private practice | 0 | 0.0% | 0 | 0.0% | 2 | 2.2% | 8 | 7.1% | 5 | 5.4% | 15 | 4.2% |
| Consulting/law/ finance | 0 | 0.0% | 0 | 0.0% | 2 | 2.2% | 4 | 3.5% | 11 | 12.0% | 17 | 4.8% |
| Other | 0 | 0.0% | 0 | 0.0% | 3 | 3.3% | 4 | 3.5% | 9 | 9.8% | 16 | 4.5% |
| Total | 10 | 100.0% | 48 | 100.0% | 92 | 100.0% | 113 | 100.0% | 92 | 100.0% | 356 | 100.0% |

Note: Trends over time for the 356 survey respondents who did not do postgraduate clinical training. Number and percentage of alumni in each graduation cohort with their first position in the indicated category. There is one survey participant, who responded to the first workplace question and did not complete postgraduate training, for whom a medical school graduation date is not available. Therefore, the sum of the rows may not equal the totals presented in the "All Years" column. The data are presented in Figure 8.

## Supplemental Table 7. Graduate Medical Education Choices for All Participating Alumni Who Have Completed Postgraduate Training by Academic Year of Medical School Graduation and Sex

| | Before 1975 | | | | 1975–1984 | | | | 1985–1994 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men | | Women | | Men | | Women | | Men | | Women | |
| Education Choice | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| No postgraduate clinical training | 10 | 12.8% | 0 | 0.0% | 42 | 9.0% | 5 | 8.9% | 75 | 9.2% | 17 | 9.4% |
| Allergy and immunology | 1 | 1.3% | 0 | 0.0% | 11 | 2.4% | 1 | 1.8% | 12 | 1.5% | 4 | 2.2% |
| Anesthesiology | 2 | 2.6% | 0 | 0.0% | 17 | 3.7% | 0 | 0.0% | 33 | 4.0% | 1 | 0.6% |
| Dermatology | 1 | 1.3% | 0 | 0.0% | 11 | 2.4% | 0 | 0.0% | 16 | 2.0% | 4 | 2.2% |
| Emergency medicine | 0 | 0.0% | 0 | 0.0% | 2 | 0.4% | 0 | 0.0% | 4 | 0.5% | 1 | 0.6% |
| Family medicine | 2 | 2.6% | 0 | 0.0% | 3 | 0.6% | 0 | 0.0% | 7 | 0.9% | 2 | 1.1% |
| Internal medicine | 31 | 39.7% | 1 | 100.0% | 157 | 33.8% | 21 | 37.5% | 219 | 26.9% | 43 | 23.9% |
| Medical genetics | 0 | 0.0% | 0 | 0.0% | 15 | 3.2% | 3 | 5.4% | 23 | 2.8% | 7 | 3.9% |
| Neurology | 3 | 3.8% | 0 | 0.0% | 44 | 9.5% | 5 | 8.9% | 76 | 9.3% | 19 | 10.6% |
| Nuclear medicine | 0 | 0.0% | 0 | 0.0% | 2 | 0.4% | 1 | 1.8% | 7 | 0.9% | 0 | 0.0% |
| Obstetrics and gynecology | 4 | 5.1% | 0 | 0.0% | 9 | 1.9% | 0 | 0.0% | 6 | 0.7% | 4 | 2.2% |
| Ophthalmology | 3 | 3.8% | 0 | 0.0% | 11 | 2.4% | 0 | 0.0% | 33 | 4.0% | 6 | 3.3% |
| Pain medicine | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Pathology | 11 | 14.1% | 0 | 0.0% | 80 | 17.2% | 16 | 28.6% | 113 | 13.9% | 31 | 17.2% |
| Pediatrics | 11 | 14.1% | 0 | 0.0% | 47 | 10.1% | 9 | 16.1% | 102 | 12.5% | 28 | 15.6% |
| Physical medicine and rehabilitation | 0 | 0.0% | 0 | 0.0% | 1 | 0.2% | 0 | 0.0% | 2 | 0.2% | 0 | 0.0% |
| Preventive medicine | 0 | 0.0% | 0 | 0.0% | 2 | 0.4% | 0 | 0.0% | 0 | 0.0% | 1 | 0.6% |
| Psychiatry | 3 | 3.8% | 0 | 0.0% | 20 | 4.3% | 2 | 3.6% | 29 | 3.6% | 17 | 9.4% |
| Radiation oncology | 0 | 0.0% | 0 | 0.0% | 4 | 0.9% | 0 | 0.0% | 12 | 1.5% | 0 | 0.0% |
| Radiology | 0 | 0.0% | 0 | 0.0% | 7 | 1.5% | 0 | 0.0% | 35 | 4.3% | 3 | 1.7% |
| Surgery: Cardiothoracic | 0 | 0.0% | 0 | 0.0% | 1 | 0.2% | 0 | 0.0% | 7 | 0.9% | 2 | 1.1% |
| Surgery: Colon and rectal | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Surgery: General | 1 | 1.3% | 0 | 0.0% | 6 | 1.3% | 0 | 0.0% | 19 | 2.3% | 2 | 1.1% |
| Surgery: Neurosurgery | 1 | 1.3% | 0 | 0.0% | 7 | 1.5% | 0 | 0.0% | 19 | 2.3% | 0 | 0.0% |
| Surgery: Orthopedic | 0 | 0.0% | 0 | 0.0% | 5 | 1.1% | 0 | 0.0% | 9 | 1.1% | 1 | 0.6% |
| Surgery: Otolaryngology | 1 | 1.3% | 0 | 0.0% | 3 | 0.6% | 0 | 0.0% | 8 | 1.0% | 0 | 0.0% |
| Surgery: Plastic surgery | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 3 | 0.4% | 1 | 0.6% |
| Surgery: Urology | 1 | 1.3% | 0 | 0.0% | 1 | 0.2% | 0 | 0.0% | 3 | 0.4% | 1 | 0.6% |
| Surgery: Vascular | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 2 | 0.2% | 0 | 0.0% |
| Combined specialities | 1 | 1.3% | 0 | 0.0% | 1 | 0.2% | 1 | 1.8% | 1 | 0.1% | 3 | 1.7% |
| Other | 4 | 5.1% | 0 | 0.0% | 26 | 5.6% | 2 | 3.6% | 27 | 3.3% | 10 | 5.6% |
| Unique number of respondents | 78 | — | 1 | — | 465 | — | 56 | — | 815 | — | 180 | — |

*(continued)*

## Supplemental Table 7. Graduate Medical Education Choices for All Participating Alumni Who Have Completed Postgraduate Training by Academic Year of Medical School Graduation and Sex *(continued)*

| | 1995–2004 | | | | 2005–2014 | | | | All Years | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men | | Women | | Men | | Women | | Men | | Women | |
| Education Choice | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| No postgraduate clinical training | 89 | 6.7% | 27 | 5.3% | 68 | 8.0% | 26 | 7.4% | 285 | 8.0% | 75 | 6.8% |
| Allergy and immunology | 5 | 0.4% | 8 | 1.6% | 8 | 0.9% | 8 | 2.3% | 38 | 1.1% | 21 | 1.9% |
| Anesthesiology | 27 | 2.0% | 11 | 2.1% | 35 | 4.1% | 10 | 2.8% | 114 | 3.2% | 22 | 2.0% |
| Dermatology | 51 | 3.8% | 23 | 4.5% | 47 | 5.5% | 24 | 6.8% | 126 | 3.6% | 52 | 4.7% |
| Emergency medicine | 18 | 1.4% | 5 | 1.0% | 19 | 2.2% | 9 | 2.5% | 43 | 1.2% | 15 | 1.4% |
| Family medicine | 13 | 1.0% | 5 | 1.0% | 4 | 0.5% | 6 | 1.7% | 29 | 0.8% | 13 | 1.2% |
| Internal medicine | 310 | 23.4% | 136 | 26.6% | 179 | 21.1% | 73 | 20.7% | 899 | 25.4% | 275 | 24.9% |
| Medical genetics | 21 | 1.6% | 13 | 2.5% | 4 | 0.5% | 6 | 1.7% | 64 | 1.8% | 29 | 2.6% |
| Neurology | 126 | 9.5% | 32 | 6.3% | 56 | 6.6% | 20 | 5.7% | 305 | 8.6% | 76 | 6.9% |
| Nuclear medicine | 4 | 0.3% | 1 | 0.2% | 6 | 0.7% | 0 | 0.0% | 19 | 0.5% | 2 | 0.2% |
| Obstetrics and gynecology | 11 | 0.8% | 23 | 4.5% | 6 | 0.7% | 5 | 1.4% | 36 | 1.0% | 32 | 2.9% |
| Ophthalmology | 48 | 3.6% | 18 | 3.5% | 36 | 4.2% | 19 | 5.4% | 131 | 3.7% | 43 | 3.9% |
| Pain medicine | 3 | 0.2% | 1 | 0.2% | 4 | 0.5% | 0 | 0.0% | 7 | 0.2% | 1 | 0.1% |
| Pathology | 158 | 11.9% | 48 | 9.4% | 107 | 12.6% | 46 | 13.0% | 473 | 13.4% | 141 | 12.8% |
| Pediatrics | 171 | 12.9% | 92 | 18.0% | 73 | 8.6% | 50 | 14.2% | 405 | 11.4% | 179 | 16.2% |
| Physical medicine and rehabilitation | 5 | 0.4% | 2 | 0.4% | 2 | 0.2% | 2 | 0.6% | 10 | 0.3% | 4 | 0.4% |
| Preventive medicine | 2 | 0.2% | 3 | 0.6% | 1 | 0.1% | 0 | 0.0% | 5 | 0.1% | 4 | 0.4% |
| Psychiatry | 70 | 5.3% | 31 | 6.1% | 47 | 5.5% | 24 | 6.8% | 169 | 4.8% | 74 | 6.7% |
| Radiation oncology | 32 | 2.4% | 13 | 2.5% | 64 | 7.5% | 16 | 4.5% | 112 | 3.2% | 29 | 2.6% |
| Radiology | 69 | 5.2% | 12 | 2.3% | 54 | 6.4% | 9 | 2.5% | 166 | 4.7% | 24 | 2.2% |
| Surgery: Cardiothoracic | 5 | 0.4% | 0 | 0.0% | 1 | 0.1% | 0 | 0.0% | 14 | 0.4% | 2 | 0.2% |
| Surgery: Colon and rectal | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.3% | 0 | 0.0% | 1 | 0.1% |
| Surgery: General | 22 | 1.7% | 11 | 2.1% | 13 | 1.5% | 5 | 1.4% | 61 | 1.7% | 18 | 1.6% |
| Surgery: Neurosurgery | 41 | 3.1% | 5 | 1.0% | 10 | 1.2% | 0 | 0.0% | 78 | 2.2% | 5 | 0.5% |
| Surgery: Orthopedic | 25 | 1.9% | 1 | 0.2% | 8 | 0.9% | 3 | 0.8% | 47 | 1.3% | 5 | 0.5% |
| Surgery: Otolaryngology | 14 | 1.1% | 8 | 1.6% | 8 | 0.9% | 0 | 0.0% | 34 | 1.0% | 8 | 0.7% |
| Surgery: Plastic surgery | 10 | 0.8% | 3 | 0.6% | 3 | 0.4% | 2 | 0.6% | 16 | 0.5% | 6 | 0.5% |
| Surgery: Urology | 14 | 1.1% | 2 | 0.4% | 6 | 0.7% | 0 | 0.0% | 25 | 0.7% | 3 | 0.3% |
| Surgery: Vascular | 3 | 0.2% | 0 | 0.0% | 0 | 0.0% | 1 | 0.3% | 5 | 0.1% | 1 | 0.1% |
| Combined specialities | 7 | 0.5% | 8 | 1.6% | 4 | 0.5% | 2 | 0.6% | 14 | 0.4% | 14 | 1.3% |
| Other | 64 | 4.8% | 32 | 6.3% | 43 | 5.1% | 20 | 5.7% | 164 | 4.6% | 64 | 5.8% |
| Unique number of respondents | 1,325 | — | 512 | — | 849 | — | 353 | — | 3,543 | — | 1,104 | — |

Note: GME specialty choices for all alumni out of training, from the survey data, displayed by sex and over time. Survey respondents were permitted to select more than one specialty of training. Survey respondents who identified an internal medicine subspecialty are included in the count of internal medicine respondents. Survey respondents who identified a pathology subspecialty are included in the count of pathology respondents. Survey respondents who identified a pediatrics subspecialty are included in the count of pediatrics respondents. Nine survey respondents for whom sex data are not available were excluded from the analysis. Additionally, medical school graduation dates were not available for 23 survey respondents who have been excluded from the analysis. Therefore, the sum of the rows may not equal the totals presented in the "All Years" column.

## Supplemental Table 8. Graduate Medical Education Choices for Participating Alumni Who Are Still in Training

| Specialty Choice | All | | Men | | Women | |
|---|---|---|---|---|---|---|
| | Number | Percentage | Number | Percentage | Number | Percentage |
| Allergy and immunology | 19 | 0.9% | 10 | 0.8% | 9 | 1.1% |
| Anesthesiology | 86 | 4.0% | 58 | 4.4% | 28 | 3.5% |
| Dermatology | 77 | 3.6% | 36 | 2.7% | 41 | 5.2% |
| Emergency medicine | 23 | 1.1% | 16 | 1.2% | 7 | 0.9% |
| Family medicine | 14 | 0.7% | 3 | 0.2% | 11 | 1.4% |
| Internal medicine | 570 | 26.8% | 383 | 28.8% | 187 | 23.6% |
| Medical genetics | 22 | 1.0% | 10 | 0.8% | 12 | 1.5% |
| Neurology | 187 | 8.8% | 113 | 8.5% | 76 | 9.6% |
| Nuclear medicine | 2 | 0.1% | 2 | 0.2% | 0 | 0.0% |
| Obstetrics and gynecology | 31 | 1.5% | 4 | 0.3% | 27 | 3.4% |
| Ophthalmology | 86 | 4.0% | 52 | 3.9% | 34 | 4.3% |
| Pain medicine | 4 | 0.2% | 3 | 0.2% | 1 | 0.1% |
| Pathology | 218 | 10.3% | 141 | 10.6% | 77 | 9.7% |
| Pediatrics | 241 | 11.3% | 125 | 9.4% | 116 | 14.6% |
| Physical medicine and rehabilitation | 9 | 0.4% | 6 | 0.5% | 3 | 0.4% |
| Preventive medicine | 3 | 0.1% | 2 | 0.2% | 1 | 0.1% |
| Psychiatry | 113 | 5.3% | 59 | 4.4% | 54 | 6.8% |
| Radiation oncology | 118 | 5.6% | 87 | 6.5% | 31 | 3.9% |
| Radiology | 108 | 5.1% | 85 | 6.4% | 23 | 2.9% |
| Surgery: Cardiothoracic | 12 | 0.6% | 8 | 0.6% | 4 | 0.5% |
| Surgery: Colon and rectal | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Surgery: General surgery | 55 | 2.6% | 34 | 2.6% | 21 | 2.6% |
| Surgery: Neurosurgery | 58 | 2.7% | 44 | 3.3% | 14 | 1.8% |
| Surgery: Orthopedic | 29 | 1.4% | 26 | 2.0% | 3 | 0.4% |
| Surgery: Otylaryngology | 23 | 1.1% | 20 | 1.5% | 3 | 0.4% |
| Surgery: Plastic surgery | 17 | 0.8% | 11 | 0.8% | 6 | 0.8% |
| Surgery: Urology | 19 | 0.9% | 13 | 1.0% | 6 | 0.8% |
| Surgery: Vascular | 4 | 0.2% | 1 | 0.1% | 3 | 0.4% |
| Combined specialities | 24 | 1.1% | 9 | 0.7% | 15 | 1.9% |
| Other | 88 | 4.1% | 53 | 4.0% | 35 | 4.4% |
| Unique number of respondents | 2,124 | — | 1,331 | — | 793 | — |

Note: GME specialty choices of alumni survey respondents who were currently in training at the time of the survey. Data are shown by sex. Numbers in each column include people who indicated they were training in multiple GME specialties. Thus, the sum of the number of respondents is greater than the unique number of respondents. The survey respondents who identified an internal medicine subspecialty are included in the count of internal medicine respondents. The survey respondents that identified a pathology subspecialty are included in the count of pathology respondents. The survey respondents that identified a pediatrics subspecialty are included in the count of pediatrics respondents. Survey respondents were permitted to select more than one specialty of training. Nine total survey respondents for whom sex data are not available were excluded from the analysis.

## Supplemental Table 9. Graduate Medical Education Choices: Most Commonly Chosen Specialties by Academic Year of Medical School Graduation

| | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | Currently in Training | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Specialty | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Internal Medicine | 32 | 40.5% | 178 | 34.2% | 262 | 26.3% | 446 | 24.3% | 252 | 21.0% | 570 | 26.8% |
| Pathology | 11 | 13.9% | 96 | 18.4% | 144 | 14.5% | 206 | 11.2% | 153 | 12.7% | 218 | 10.3% |
| Pediatrics | 11 | 13.9% | 56 | 10.7% | 130 | 13.1% | 263 | 14.3% | 123 | 10.2% | 241 | 11.3% |
| Neurology | 3 | 3.8% | 49 | 9.4% | 95 | 9.5% | 158 | 8.6% | 76 | 6.3% | 187 | 8.8% |
| No GME | 10 | 12.7% | 47 | 9.0% | 92 | 9.2% | 116 | 6.3% | 94 | 7.8% | 0 | 0.0% |
| Surgery (all) | 4 | 5.1% | 23 | 4.4% | 77 | 7.7% | 164 | 8.9% | 61 | 5.1% | 217 | 10.2% |
| All other | 16 | 20.3% | 122 | 23.4% | 269 | 27.0% | 548 | 29.8% | 475 | 39.5% | 715 | 33.7% |
| Unique Individuals | 79 | — | 521 | — | 995 | — | 1,837 | — | 1,202 | — | 2,124 | — |

Note: GME specialty choices in the six most commonly chosen specialties for survey respondents who have completed training over time. The number and percentage of alumni in each graduation cohort choosing the indicated GME specialty are shown. Surgery (all) includes cardiothoracic, colon and rectal, general surgery, neurosurgery, orthopedic, otylaryngology, plastic surgery, urology, and vascular. The data are illustrated in Figure 14.

## Supplemental Table 10. Graduate Medical Education Choices: Less Commonly Chosen Specialties by Academic Year of Medical School Graduation

| Specialty | Before 1975 | | 1975–1984 | | 1985–1994 | | 1995–2004 | | 2005–2014 | | Currently in Training | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage | Number | Percentage |
| Anesthesiology | 2 | 2.5% | 17 | 3.3% | 34 | 3.4% | 38 | 2.1% | 45 | 3.7% | 86 | 4.0% |
| Dermatology | 1 | 1.3% | 11 | 2.1% | 20 | 2.0% | 74 | 4.0% | 71 | 5.9% | 77 | 3.6% |
| Emergency Medicine | 0 | 0.0% | 2 | 0.4% | 5 | 0.5% | 23 | 1.3% | 28 | 2.3% | 23 | 1.1% |
| Obstetrics and Gynecology | 4 | 5.1% | 9 | 1.7% | 10 | 1.0% | 34 | 1.9% | 11 | 0.9% | 31 | 1.5% |
| Ophthalmology | 3 | 3.8% | 11 | 2.1% | 39 | 3.9% | 56 | 3.6% | 86 | 4.6% | 86 | 4.0% |
| Psychiatry | 3 | 3.8% | 22 | 4.2% | 46 | 4.6% | 101 | 5.5% | 71 | 5.9% | 113 | 5.3% |
| Radiology | 0 | 0.0% | 7 | 1.3% | 38 | 3.8% | 81 | 4.4% | 63 | 5.2% | 108 | 5.1% |
| Radiation Oncology | 0 | 0.0% | 4 | 0.8% | 12 | 1.2% | 45 | 2.2% | 80 | 6.7% | 118 | 5.6% |
| Unique individuals | 79 | — | 521 | — | 995 | — | 1,837 | — | 2,020 | — | 2,124 | — |

Note: Number and percentage of alumni survey respondents in each graduation cohort choosing the indicated GME specialties. The data are illustrated in Figure 14.

# Notes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9. Table B-7: M.D.-Ph.D. Applicants to U.S. Medical Schools by Race/Ethnicity and State of Legal Residence, 2016–2017. Association of American Medical Colleges. Email datarequest@aamc.org for a copy of this table.
10. Table B-8: U.S. Medical School M.D.-Ph.D. Applications and Matriculants by School, In-State Status, and Sex, 2016–2017. Association of American Medical Colleges. Email datarequest@aamc.org for a copy of this table.
11. Table B-13: M.D.-Ph.D. Graduates of U.S. Medical Schools by Race/Ethnicity, 2015–2016. Association of American Medical Colleges. Email datarequest@aamc.org for a copy of this table.
12. Table B-2.2: Total Graduates by U.S. Medical School and Sex, 2011–2012 through 2015–2016. Association of American Medical Colleges. Email datarequest@aamc.org for a copy of this table.
13. Table A-9: Matriculants to U.S. Medical Schools by Race, Selected Combinations of Race/Ethnicity and Sex, 2013–2014 through 2016–2017. Association of American Medical Colleges. Email datarequest@aamc.org for a copy of this table.
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18. The number of training programs is from https://www.nigms.nih.gov/Training/InstPredoc/Pages/PredocOverview-MSTP.aspx. Accessed January 31, 2017. The number of MSTP T32 positions was provided through personal communication with Peter Preusch, PhD, the former NIGMS program official for the MSTP. The NIH supports additional MD-PhD trainees through the NIH Graduate Partnerships Program (https://www.training.nih.gov/programs/gpp, accessed January 31, 2017) and individual F30 and F31 awards.

19. There are no published estimates of the fraction of the total costs of MSTP-funded MD-PhD programs that are covered by a NIGMS T32 MSTP budget, but the experience of two authors of this report (MHA and LFB) from doing grant reviews is that it averages 20%–25% and at some institutions it is considerably less.

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31. AAMC records show that in 2016 there were 143 medical schools with an MD-PhD program. However, 31 reported having no trainees and 20 had 10 or fewer. Of the 92 programs with more than 10 trainees, 80 participated in this study. In 2016, these 80 participating programs enrolled 4,815 trainees, while the 63 nonparticipating programs had in aggregate only 434 (8% of the total). The percentage of alumni who graduated from the nonparticipating programs is unknown but presumed to be, if anything, even less than 8% because these programs are generally relatively recently developed. One MD-PhD alumni from a program other than the 80 participating programs participated in the study.

32. Table B-11.2: Total M.D.-Ph.D. Enrollment by U.S. Medical School and Sex, 2012–2013 through 2016–2017. Association of American Medical Colleges. Published December 19, 2016. Email datarequest@aamc.org for a copy of this table.

33. As stated in note 31 above, one MD-PhD alumni from a program other than the 80 participating programs participated in the study.

34. Table 33. U.S. Medical School M.D.-Ph.D. Applications and Matriculants by School, In-State Status, and Sex, 2014. Association of American Medical Colleges. Published December 1, 2014. Email datarequest@aamc.org for a copy of this table.

35. Reported in academic year 2014–2015 as 11%–18% depending on the breakout of those listed in AAMC FACTS data as "multiple race/ethnicity" in Table A-9: Matriculants to U.S. Medical Schools by Race, Selected Combinations of Race/Ethnicity and Sex, 2013-2014 through 2016-2017. Email datarequest@aamc.org for a copy of this table.

36. Data from Diversity Resources and Data Snapshots. Association of American Medical Colleges. https://www.aamc.org/download/431540/data/may2015pp.pdf. Published May 2015. Accessed November 6, 2017.

37. Retired alumni were scored according to their last permanent workplace. Deceased alumni were omitted.

38. An informal poll of program leaders, who often have workplace data for the alumni who did not participate in the present survey, suggests that about 24% of alumni out of training are in private practice. Although this is an extrapolation that cannot be verified at this time, it is worth noting that the same dataset provided by program leaders shows that 57% of all alumni out of training hold full-time academic appointments, which is nearly identical to the 58% calculated from the data on all alumni in the AAMC Faculty Roster. These data indicate that the survey respondents are more likely to be in academia and less likely to be in private practice than the nonrespondents.

39. We did not take into account any leaves of absence (personal, medical, or academic) that might have occurred.

40. We stopped with academic year 2003–2004 because two-thirds of the alumni who have graduated since then are still in postgraduate training.

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