Falling out of Step: Diversity along the Pathway to a Career in Biomedical Research

Misty L. Heggeness[1]
National Institutes of Health

Lisa Evans
National Institutes of Health

Jennifer Pohlhaus
Ripple Effect Communications, Inc.

Sherry Mills
National Institutes of Health

November 7, 2014

This paper was written for the Association of Public Policy Analysis and Management (APPAM) 2014 Research Conference in Albuquerque, New Mexico. It has undergone a more limited review than official publications. Any views expressed are those of the authors and not necessarily those of the National Institutes of Health. Do not cite without the authors' permission.

[1] Corresponding author: Misty L. Heggeness, Labor Economist, National Institutes of Health, 6705 Rockledge Drive, Suite 350, Bethesda, MD 20892, Phone: 301-435-2695, Email: misty.heggeness@nih.gov.

Abstract

This study examines the career pathway of biomedical scientists along the educational pipeline from high school to advanced degree and on through to NIH-funded investigator. Using a relevant labor market perspective, we examine U.S. Census data to determine how transition points along this path vary by gender, race, and citizenship. Critical transition points are high school, associate, bachelor, and graduate degree completion, as well as the award of an NIH research grant. With recent data (2008-2012), we update previously published estimates and identify where various groups are leaving or entering the pipeline and to what extent.

As the premier biomedical research institution in the world and the steward of medical and behavioral research for the Nation, the National Institutes of Health (NIH) continuously strives to draw on and develop the best scientific minds and talents. The NIH has focused recent efforts on promoting diversity in the biomedical research workforce and enhancing opportunities for participation among underrepresented groups. Enriching the pool of scientists and promoting diversity in the biomedical, behavioral, clinical and social sciences research workforce helps to ensure the production of new knowledge that improves the health of the Nation's citizens while preparing emerging scientific talent for an increasingly diverse workforce and society.

NIH's capacity to ensure that it remains a global leader in scientific discovery and innovation is dependent upon a nationally diverse scientific workforce. Within the framework of NIH's longstanding commitment to excellence and projected need for investigators in particular areas of research, attention must be given to the participation of trainees and grantees from underrepresented groups. Underrepresented groups include racial, or ethnic groups that are underrepresented in the biomedical sciences, individuals with disabilities, individuals from disadvantaged backgrounds that have inhibited their ability to pursue a research career, and women at senior career levels of academia.

In this paper, we focus our efforts on understanding the composition of individuals throughout the educational pipeline up to becoming a biomedical researcher funded by the National Institutes of Health. In doing so, we adapt a representation ratio methodology used previously (Myers & Turner (2004); Myers & Husbands-Fealing (2012)). We highlight the importance of understanding representation ratios, not only by race, but by gender and citizenship as well. We paint a complex picture of outcomes for biomedical researchers dependent on multiple factors. We find evidence that representation ratios differ not only by race, but by race and gender and by race, gender, and citizenship status. Overall, these results improve our understanding of focal points along the pipeline for diverse groups within the NIH biomedical research career path and suggest areas for potential intervention.

Background

Lack of diversity among biomedical research professionals is not merely an issue of demographic equity; it potentially undermines the realization of our national research goals. Studies on the effects of diversity by Leonard (2006), Gurin (1999), and Hong (2001) have reported that diversity leads to greater stability in the workforce,[2,] enhanced intellectual engagement and motivation,[3] and improved decision-making in groups.[4,5] Further, Denson (2009) argues that diversity is particularly beneficial in promoting innovation.[6]

The National Academies report, Beyond Bias and Barriers (2007), described the underrepresentation of women in academic science and engineering in the United States as a systematic failure in realizing the potential of women scientists and engineers.[7] The case is made that equitable opportunities, resources, and support for all people will profoundly enhance the talent pool of scientists and engineers. Likewise, the National Academies report, Expanding Underrepresented Minority Participation (2011), states that minority participation in science, technology, engineering, and mathematics (STEM) education at all levels should be an urgent national priority.

---

[2] Leonard, J. &. (2006, July). The Effect of Diversity on Turnover: A Large Case Study. *Industrial and Labor Relations Review, 59*(4), 547-572.
[3] (Gurin 1999)
[4] (Hong 2001)
[5] (L. P. Hong 2004)
[6] (Denson 2009)
[7] (National Academy of Sciences (US), National Academy of Engineering (US), and Institute of Medicine (US) Committee on Maximizing the Potential of Women in Academic Science and Engineering.)

Ginther et al. (2011) reported on the disparities between ethnic or racial populations in the number of R01 research grants awarded by the NIH. Specifically, African-American applicants were found to be 10 percentage points less likely than whites to be awarded NIH research funding after controlling for the applicant's educational background, country of origin, training, previous research awards, publication record, and employer characteristics.[8]

According to Myers (2011), efforts to increase diversity produce costs as well as benefits.[9] The work of Alesina (2000 & 2005) and Ancona (1992) describe the potential for diversity to lower trust levels[10,11] or lead to conflicts within groups, which can impede performance.[12] Myers suggests a cost-benefit analysis to determine whether an increase in diversity will have a net positive effect.

In scientific research, a strong case has been made that diversity is a worthwhile goal with benefits including increased creativity, a broader scope of inquiry, and promoting fairness, which exceed any unintended costs. Indeed, taking advantage of the benefits of a diverse workforce is seen as an opportunity that the U.S. cannot afford to squander.

Internationalization of the U.S. Science and Engineering Labor Market

Currently, the U.S. science and engineering workforce is composed of many foreign-born workers in addition to U.S. born citizens. According to the National Science Foundation (NSF), almost 30 percent of the actively employed science and engineering doctorate holders in the United States in 2004 were foreign born, as were many postdocs.[13] Over-reliance upon people

[8] (Ginther 2011)
[9] (Myers 2011)
[10] (Alesina 2000)
[11] (Alesina, Ethnic Diversity and Economic Performance 2005)
[12] (Ancona 1992)
[13] National Science Foundation (NSF). *Science and Engineering Indicators 2004.* [Online] Available at: http://www.nsf.gov/statistics/seind04/c2/c2s4.htm#c2s4l2 [accessed April 8, 2011].

who are born abroad leaves the United States vulnerable in various ways.[14] There is a concern within the scientific community that the pool of foreign-born workers may decline or disappear in the future. Other countries may begin to look abroad to supplement their own labor pools, particularly in technical fields. As the standard of living increases in other countries, foreigners also may be enticed by improving labor markets to return to their country of origin. The demand for talented workers will continue to increase in the coming decades, as a significant proportion of the Nation's scientists start aging out of the workforce.[15]

Given the current demographic composition of science and engineering fields, the National Science and Technology Council reports that there will be an overall shortfall in the scientific workforce by the year 2050 if corrective actions are not taken. Promoting diversity within programs is a means to achieve a possible alternative to maintain the strength and population in the U.S. research workforce.

Relevant Labor Market

Many discussions about the demographics of the biomedical workforce focus on the representation of underrepresented groups participating in NIH-funded extramural programs, but do not evaluate the context within which these comparisons exist. For example, some discussions about diversity assume that the proportion of individuals engaged in biomedical research or receiving NIH funding should be equal to the proportion of women, racial and ethnical minorities, or persons with disabilities in the total U.S. population. However, in order to

---

[14] National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. 2011. *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads.* Washington, DC: The National Academies Press.
[15] Building Engineering & Science Talent (BEST). 2004. *The Talent Imperative: Meeting America's Challenge in Science and Engineering, ASAP*. [Online] Available at: http://www.bestworkforce.org/PDFdocs/BESTTalentImperativeFINAL.pdf [accessed April 8, 2011].

appropriately evaluate where the NIH-funded workforce is, and where it could realistically be, one can rely on well-established employment law principles.

Based on several key legal decisions over the past 4 decades, the Supreme Court has held that the proportion of individuals hired in any workforce should be proportionate to the skilled workforce available to compete for those positions. The "relevant labor market" concept was first articulated in *Hazelwood School District v. United States*, 433 U.S. 299, 1977. Since *Hazelwood*, several more landmark decisions have cited and added to the understanding of the relevant labor market, including use of analysis, quantifying statistics, and geographic labor market definitions.

Determination of the relevant labor market is necessary when employers conduct a utilization analysis and an availability analysis. A utilization analysis consists of describing the percentages of a protected group (e.g., race or sex) of employees by occupation within the current employer's workforce. An availability analysis reports a similar percentage breakdown by protected class, but for applicants and prospective employees who reside within a geographic area that defines the employer's relevant labor market. A discrepancy between these percentages, where the employer's workforce percentage of protected class members is less than the percentage observed for the relevant labor market, is described as "underutilization." The disparity between the utilization percentage and availability percentage should be statistically significant, meaning unlikely to have occurred by chance. Underutilization may call for voluntary or court-ordered affirmative action to close identified gaps.

NIH Actions to Date

The NIH has a long history of support for research training of the biomedical researchers beginning with a fellowship program that was created during the formation of the NIH in 1930.

In 1974, Congress consolidated NIH's research training authorities and established its current system of institutional training grants and individual fellowships. Currently, research training is supported by NIH through "formal" and "informal" mechanisms. Formal mechanisms include institutional training awards, individual fellowships, and career development awards (both institutional and individual). Informally, many students and postdocs are trained by mentors and supported on the mentor's research awards.

The NIH has developed targeted programs designed to enhance the pool of individuals from diverse backgrounds who are underrepresented in biomedical and behavioral science and available to participate in NIH-funded research. In 2004, the NIH revised its Minority Supplement Program to broaden eligibility criteria to include multiple forms of disadvantage (race/ethnicity, disability, socioeconomic status). The NIH also has established a number of internal and external task forces that report directly to the NIH Director with the goal of facilitating NIH-wide strategic planning in achieving diversity in the biomedical research workforce.

In 2007, NIH formed the internal Working Group on Women in Biomedical Careers[16] to maximize the potential of women scientists and engineers. In 2011, the NIH Advisory Committee to the Director established two Working Groups composed of internal and external subject matter experts. The Biomedical Workforce Task Force[17] was formed to develop a model for a sustainable and diverse U.S. biomedical research workforce that can inform decisions about training of the optimal number of people for the appropriate types of positions that will advance science and promote health.

[16] http://womeninscience.nih.gov/workinggroup/
[17] http://biomedicalresearchworkforce.nih.gov

Motivated in part by Ginther's (2011) findings about disparities in research grant awards across groups, the ACD Working Group on Diversity in the Biomedical Research Workforce was formed and charged with providing concrete recommendations toward improving the recruitment and retention of underrepresented minorities, people with disabilities, and people from disadvantaged backgrounds across the lifespan of a biomedical research career.

These working groups have advanced our understanding of the challenges of pursuing a biomedical career and have kick-started initiatives to cultivate biomedical careers that attract the best and brightest minds regardless of gender, race, ethnicity or disability. This work has been aligned with the mandate of the Office of Research on Women's Health that includes the development of opportunities and programs to support recruitment, retention, re-entry, and advancement of women in biomedical careers (Public Law 103-43 June 1993).

Data

The data for this paper come from two sources: the NIH Information for Management, Planning, and Coordination II (IMPACII) database and the IPUMS American Community Survey (ACS) 2008-2012 5-year file (Ruggles et al. 2010). We use IPUMS-ACS data to calculate representation ratios for individuals by gender, race/ethnicity, and citizenship status from high school diploma to advanced degree. ACS data is a nationally representative household survey conducted by the U.S. Census Bureau annually since 2000. To account for small sample size by subgroup, we use the IPUMS-ACS 5-year file, which pools 5 years of data together in one file. This file is used by the Census Bureau to calculate public statistics of small subpopulations within the U.S.

We pull data on NIH trainees, fellows, and grantees from 2008 to 2012 using the IMPACII administrative data. All data are reported for the specified fiscal years (October 1 to September 30). Data for race/ethnicity, sex, citizenship, and age of the applicants and awardees are self-reported in their eRA Commons profiles; counts change over time as individuals edit their profiles. Data for race/ethnicity, sex, citizenship, and age of T32 trainees were submitted by T32 principal investigators (PIs) through the "Statement of Appointment" form. We retrieved IMPACII data in October 2014. We consequently performed analyses for fiscal years 2008 to 2012, inclusive.

Representation ratios shown in this paper are calculated from 5-year pooled data of the IPUMS-ACS and the NIH IMPACII administrative data. The authors used the person weights (i.e., inverse probability of selection into the sample and adjustments to account for the complex stratified sampling scheme) from the IPUMS-ACS dataset and the population values from the IMPACII dataset to compute the representation ratios.

Methodology

Representation Ratios

One method to analyzing the relevant labor market is to compute representation ratios at each stage of career development.[18] To determine representation ratios, the authors calculated the

[18] Samuel L. Myers Jr., Caroline S. Turner. "The Effects of Ph.D. Supply on Minority Faculty Representation." *American Economic Review* (2004): 296-301. Samuel L. Myers, Jr. and Kaye Husbands Fealing. "Changes in the Representation of Women and Minorities in Biomedical Careers." *Diversity and Inclusion in Academic Medicine* (2012): 1525-1529.

probability of male, female, white (non-Hispanic), black (non-Hispanic), Asian (non-Hispanic), American Indian (non-Hispanic), and Hispanic subgroups in obtaining the following degrees or diplomas: high school, associate, bachelor, and advanced degree (Professional or PhD). Probabilities were calculated for each gender and race/ethnicity, as well as for each gender by race/ethnicity, overall and by citizenship status.

The authors calculated the probability, $P(j)^k$, of subgroup k obtaining the j^{th} degree (e.g., bachelor's). $P(j)^k$ is used to denote the probability that a member of the k^{th} group (e.g. Hispanics) would obtain the j^{th} degree. Thus, the interpretation of the resulting ratio, $R(j)^k$, is the k^{th} group's probability of obtaining the j^{th} degree relative to the overall probability of obtaining the j^{th} degree in the relevant population.

When this ratio is greater than 1, the group's probability of earning the j^{th} degree exceeds the overall probability of earning the j^{th} degree, or the k^{th} group is overrepresented as a j^{th} degree earner. When the ratio is less than 1, the group is underrepresented. When the ratio is equal to 1, the group's representation among recipients of the j^{th} degree is equal to the group's representation in the relevant population overall.

Defining the Relevant Population

The relevant population is the "risk population" that the person earning the degree in question comes from (Figure 1). For example, bachelor's degree recipients are the relevant population for potential master's degree earners because a bachelor's degree is required for entry into a master's degree program. A person whose highest level of education is 12th grade is outside the relevant population of potential master's degree recipients because the person does not meet the prerequisites for entry into a master's degree program. Thus, the number of individuals in a subgroup with a bachelor's degree is divided by the number of individuals within the subgroup with a high school diploma all over the total population with a bachelor's degree divided by the total population with a high school diploma to determine if the group earns bachelor's degrees at the same rate bachelor's degrees are earned within the total population of people who have a high school diploma or its equivalent.

Probability of earning…	**Relevant Population**
High school diploma	Total population over age 25
Associate's degree	Population with high school diploma or equivalent
Bachelor's degree	Population with high school diploma or equivalent
Advanced degree and employed as a biomedical researcher • Professional (e.g. MD) • PhD	Population with bachelor's degree
NIH Postdoc	Population with advanced degree (Professional or PhD) and employed as a biomedical researcher
NIH Independent Mentored K Award	Population with advanced degree (Professional or PhD) and employed as a biomedical researcher
NIH Research Award	Population with advanced degree (Professional or PhD) and employed as a biomedical researcher

Results

There are differences by gender in representation ratios along the academic pipeline to becoming an NIH funded biomedical researcher. Our analysis (Table 1A and Table 2) shows that men are less likely to get an associate degree and more likely to get an advanced degree. Once they are in the NIH-funded pool, they are underrepresented in postdoctoral positions and mentored K awards. However, they are overrepresented in the R01 -equivalent pool, implying that overall they are more successful than women at attaining the coveted R01 grant as a Principal Investigator (PI). Women, in general, are overrepresented in postdoctoral positions and mentored K awards.

White, non-Hispanic individuals are overrepresented in high school and bachelor degrees but underrepresented in acquiring an advanced degree and working in biomedical science professions (Table 3). However, once they are in the pool of receiving an advanced degree and working in biomedical science, they are overrepresented in all aspects of NIH funding: postdoctoral positions, mentored K awards, and R01-equivalent awards.

Other groups have mixed results (Table 3). Black, non-Hispanic individuals are underrepresented before entering the NIH pool (meaning in bachelor and advanced degrees). Once they reach the NIH pool, they are overrepresented in postdoctoral positions funded by NIH, as well as in mentored K awards. However, they have the lowest representation ratio (0.35) of any racial or ethnic group in R01-equivalent grants. Hispanic individuals are underrepresented throughout the pipeline. In fact, they are overrepresented only in mentored K awards. Asian, non-Hispanic individuals are overrepresented in bachelor and advanced degrees but underrepresented in all NIH funded support that we examined.

We find that there are differences in sex by race and ethnicity. In general within race and ethnicity, men have higher representation compared to women along the pipeline through to advanced degree (Table 4). Upon entering the NIH funding system, the experience is generally reversed. We find that white, non-Hispanic and black, non-Hispanic women are overrepresented in postdoctoral positions and mentored K awards. Hispanic women are also overrepresented in mentored K awards. Asian, non-Hispanic women, while underrepresented, have higher representation ratios for postdoc and mentored K awards than their male counterparts. Overall among NIH R01-equivalent awardees, men do better than women. Particularly, white, non-Hispanic males do better than males of any other race and all women. All groups except white, non-Hispanic males are underrepresented in R01-equivalent grants.

Gender, race, and ethnicity are only part of the story since some NIH funded awards and grants are only available to U.S. citizens. We also examine citizenship status and citizenship status by gender and race and ethnicity. We find that U.S. citizens, while underrepresented in advanced degrees, are overrepresented in all NIH funding mechanisms we examine (Table 5). Additionally, while non-citizens are overrepresented in advanced degrees, they are underrepresented in all NIH funding mechanisms.

In general, non-citizens have higher representation ratios than their citizen counterparts by race up through advanced degree (Table 6 (A-D)). Hispanic individuals (of any race) who are citizens have greater representation ratios (while still underrepresented) at the high school and bachelor degree stage. However, Hispanic individuals (of any race) are overrepresented in advanced degrees, working in biomedical sciences, compared to Hispanic U.S. citizens. All non-citizen race and ethnic groups are underrepresented in the NIH-funded pool.

Our final analysis is to identify representation ratios by gender, race/ethnicity, and citizenship status (Table 7). While white, non-Hispanic male citizens are underrepresented in advanced degrees, they are overrepresented in receiving NIH-funded positions. The reverse is true for non-citizen white, non-Hispanic males – however while non-citizen males are only slightly underrepresented within NIH R01-equivalent awardees. White, non-Hispanic female citizens are overrepresented in postdoctoral positions and mentored K awards and slightly overrepresented in R01-equivalent awardees.

Other groups have mixed results. Black, non-Hispanic citizens, both male and female, are overrepresented in postdoctoral positions and mentored K awards. However, while male black, non-Hispanic citizens have a higher representation ratio than their female counterparts, both groups are underrepresented in NIH R01-equivalent awardees.

Hispanic male citizens are overrepresented in all NIH funding mechanisms. Their female equivalents are overrepresented in postdoctoral positions and mentored K awards, but underrepresented in R01-equivalent funding. Male Asian, non-Hispanic citizens are overrepresented in mentored K awards and R01-equivalent grants. Their female counterparts are overrepresented in postdoctoral and mentored K grants. Asian, non-Hispanic citizens have higher representation ratios than their non-citizen counterparts.

Discussion

Women are overrepresented in Associate (2-year) degrees and Master degrees. African Americans (NH) and American Indians (NH) are overrepresented in Associate (2-year) degrees. Their overrepresentation in these pools does not position them to enter the NIH biomedical workforce pipeline since 98 percent of NIH grantees in our sample have a Professional degree, PhD, or equivalent (98 percent in our sample).

Within the NIH grantee pool, women and other historically underrepresented groups are overrepresented as trainees and fellows and in K grants. Men are overrepresented in R01-equivalent grants. White, non-Hispanic men have a representation ratio of 1.63 in R01 grants, meaning that they are 63 percent more likely to be in the R01-equivalent pool than their proportion in the advanced degree pool.

However, looking at gender only, race only, or even the combination of gender and race is not the entire story. When we analyze the data by also examining citizenship status, we find that the overrepresentation of white, non-Hispanic men is only true for white, non-Hispanic men who are citizens (and not true of their non-citizen counterparts). There is also an overrepresentation of Hispanic males and Asian, non-Hispanic citizen males. White, non-Hispanic citizen women are close to parity when it comes to their representation within R01-equivalent grants.

More exploration is needed to understand why some underrepresented groups fall off the biomedical career pathway between postdoc and K support and the R01-equivalent awards. Are there institutional barriers or biases that disproportionately impact persons from underrepresented backgrounds? Are these individuals self-selecting out because they have different preferences? What are the “push or pull” factors that influence persistence in scientific careers? What side of the coin is it (or is it both)?

Current NIH policies around diversity and training do not appear to hinder, at a minimum, the ability of underrepresented groups to participate in postdoctoral positions and K awards. They have potentially had a positive impact on the representation ratios for these groups in these programs (although more analysis is required to determine to what extent this is the case).

It might be worthwhile to consider the underlying causes as to why more women and underrepresented groups do not appear in the R01 pool. If it is a case of self-selecting out and differences in preferences (increased value on work-life balance, etc.), then implementing diversity programs on the R01 pool of candidates will have no or minimal effect. For example, previous studies have shown that the underrepresentation of women in R01-equivalent awards is largely due to their underrepresentation in the application pool, not because of differences in success rates.

Conclusion

We have argued that representation needs to take place within the context of the relevant labor market consistent with longstanding principles of employment law. For purposes of our study, we identify the NIH relevant labor market as those individuals with advanced degrees and currently working as a biological or medical scientist. When we compare the pool of NIH funded individuals in the relevant labor market, we find a general conclusion that underrepresented groups are overrepresented in training programs (postdoc and K support) and underrepresented in R01-equivalent grants. However, the story is more complicated when we add in the variable of citizenship. We find evidence that citizens who are male, white (non-Hispanic), Asian (non-Hispanic), or Hispanic are overrepresented in the NIH R01-equivalent pool. White (non-Hispanic) women are almost equally represented in the NIH R01-equivalent pool. Citizens who are black (non-Hispanic) men and women, Hispanic women, and Asian (non-Hispanic) women are underrepresented in the NIH R01-equivalent pool. All non-citizens are underrepresented in all aspects of NIH funding mechanisms.

This paper advances our knowledge of the dynamics associated with diversity along the biomedical career pipeline and suggests intriguing questions for further study. We find similar results to those of Myers & Husbands-Fealing (2004), as well as the results of Ginther et al. (2012). Additionally, we report on citizenship and focus on the outcomes of NIH funded individuals. Our analysis does not allow us to identify what factors are influencing the diverse outcomes we see based on their relevant labor market.

NIH has been working to establish the capacity to answer these and other questions about the workforce. NIH's first Chief Officer for Scientific Workforce Diversity was named in January 2014. NIH also has established a new Division of Biomedical Research Workforce (DBRWP), which resides in the Office of Extramural Research to provide ongoing analysis of the biomedical research workforce and evaluation of NIH policies to enable NIH to sustain and grow the biomedical research workforce at all levels to assure the most productive biomedical research endeavors and most effective use of taxpayer dollars. This study is one step further towards developing comprehensive long-term strategies to address all components of the biomedical research enterprise, including trainees, biomedical researchers in academia and industry, and scientists in research-related occupations.

References

Alesina, A. L. (2000). Participation in Hetergeneous Communities. *The Quarterly Journal of Economics , 115*(3), 847-904.

Alesina, A. L. (2005). Ethnic Diversity and Economic Performance. *Journal of Economic Literature*, *43*(3), 762-800.

Ancona, D. C. (1992). Demography and Design: Predictors of New Product Team Performance. *Organization Science, 3*(3), 321-341.

Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline. (2011). *Expanding Underrepresented Minority Participation.* Washington, DC: National Academies Press.

Denson, N. C. (2009, June). Racial Diversity Matters: The Impact of Diversity-Related Student Engagement and Instituional Context. *American Education Research Journal, 46*(2), 322-353.

Ginther, D. K. (2011, August 19). Race, Ethnicity, and NIH Research Awards. *Science, 333*(6045), 1015-1019.

Gurin, P. (1999). The Compelling Need for Diversity in Education. *Expert report prepared for the lawsuits Gratz and Hamacher v Bollinger, Duderstadt, the University of Michigan, and the University of Michigan College of LS&A, Civil Action No. 97-75231 (U.S. District Court, Eastern District of Michigan) and Grutter v Bollinger, Lehman, Shields, the University of Michigan and the University of Michigan Law School, Civil Action No. 97-75928*.

Hong, L. P. (2001). Problem Solving by Hetergenous Agents. *Journal of Economic Theory, 97*, 123-163.

Hong, L. P. (2004). Groups of Diverse Problem Solvers Can Outperform Groups of High-Ability Problem Solvers. *Proceedings of the National Academy of Sciences in the United States of America, 101*(46), 16385-16389.

Leonard, J. &. (2006, July). The Effect of Diversity on Turnover: A Large Case Study. *Industrial and Labor Relations Review, 59*(4), 547-572.

Myers, S. J. (2011). The Economics of Diversity. In J. H. Norman J. Johnson (Ed.), *And Justice for All: Promoting Social Equity in Public Administration* (pp. 100-119). New York: M.E. Sharp, Inc.

National Academy of Sciences (US), National Academy of Engineering (US), and Institute of Medicine (US) Committee on Maximizing the Potential of Women in Academic Science and Engineering. (2007). *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Sciences and Engineering.* Washington: National Academies Press. Retrieved from www.nap.edu

Samuel L. Myers Jr., C. S. (2004). The Effects of Ph.D. Supply on Minority Faculty Representation. *American Economic Review*, 296-301.

Samuel L. Myers, J., & Fealing, K. H. (2012). Changes in the Representation of Women and Minorities in Biomedical Careers. *Diversity and Inclusion in Academic Medicine*, 1525-1529.

Steven Ruggles, J. T. (2010). Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]. Minneapolis, MN.

Figures and Tables

Figure 1: Framework

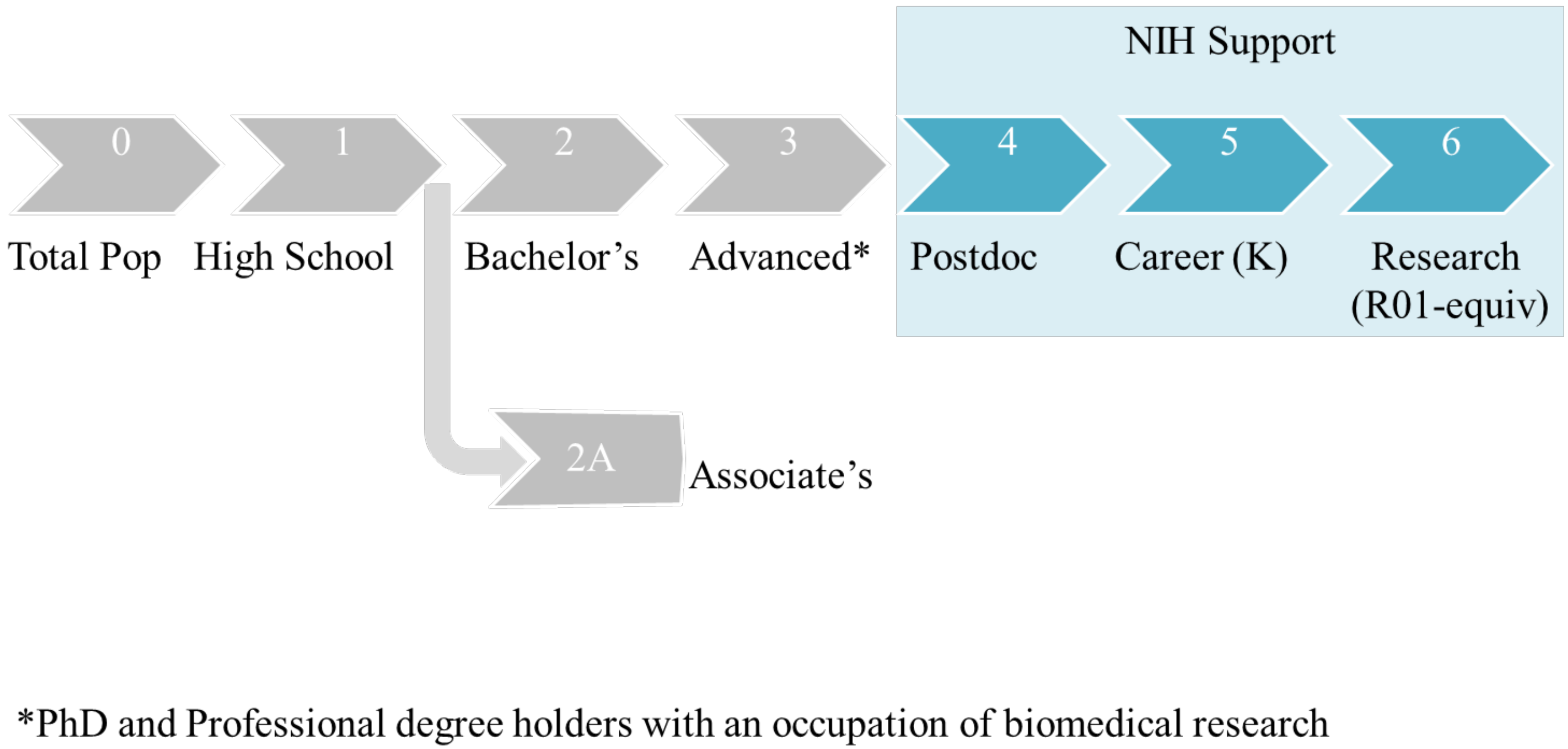

Table 1. Terminal Associates Degree
A. Sex Differences

	High School	Associates
Male	1.00	0.90
Female	1.00	1.09

B. Race Differences

	High School	Associates
White, NH	1.06	1.01
Black, NH	0.98	1.03
Hispanic	0.76	0.97
Asian, NH	1.01	0.89
American Indian, NH	0.95	1.14

Table 2. Sex Differences

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
Male	1.00	1.02	1.17	0.82	0.92	1.22
Female	1.00	0.98	0.83	1.18	1.07	0.67

Table 3. Race and Ethnicity Differences

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
White, NH	1.06	1.04	0.72	1.21	1.07	1.33
Black, NH	0.98	0.67	0.43	1.41	1.17	0.35
Hispanic	0.76	0.63	0.68	0.87	1.20	0.74
Asian, NH	1.01	1.68	3.25	0.41	0.56	0.45
American Indian, NH	0.95	0.52	not reported			

Table 4. Sex Differences by Race

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
White, NH Males	1.05	1.08	0.82	1.01	0.99	1.63
White, NH Females	1.06	1.01	0.62	1.44	1.17	0.92
Black, NH Males	0.96	0.61	0.55	0.88	0.94	0.38
Black, NH Females	0.99	0.72	0.35	1.63	1.42	0.30
Hispanic, Males	0.74	0.60	0.83	0.84	0.97	0.89
Hispanic, Females	0.77	0.66	0.55	0.88	1.49	0.55
Asian, NH Males	1.03	1.74	3.89	0.33	0.56	0.57
Asian, NH Females	0.99	1.62	2.64	0.50	0.57	0.28
American Indian, NH Males	0.94	0.47	not reported			
American Indian, NH Females	0.96	0.56	not reported			

Table 5. Citizenship Differences

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
Citizen	1.03	0.98	0.65	1.60	1.40	1.36
Noncitizen	0.72	1.07	4.75	0.32	0.62	0.42

Table 6. Citizenship Differences by Race

A. White, NH

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
Citizen	1.06	1.03	0.58	1.51	1.22	1.42
Noncitizen	1.02	1.38	5.13	0.35	0.72	0.72

B. Black, NH

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
Citizen	0.97	0.64	0.32	2.01	1.65	0.43
Noncitizen	0.95	0.83	1.40	0.64	0.39	0.16

C. Hispanics

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
Citizen	0.89	0.66	0.49	1.53	2.00	1.11
Noncitizen	0.53	0.47	1.53	0.38	0.67	0.36

D. Asian, NH

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
Citizen	1.03	1.62	2.17	0.98	1.15	1.00
Noncitizen	0.98	1.88	6.36	0.24	0.45	0.21

Table 7. Sex Differences by Citizenship & Race

	High School	Bachelors	Advanced	NIH Postdoc	K Awardee	R01 Equivalent
White, NH Males: Citizen	1.06	1.07	0.66	1.27	1.11	1.76
White, NH Males: Noncitizen	1.03	1.49	5.62	0.28	0.76	0.90
White, NH Females: Citizen	1.06	1.00	0.50	1.79	1.35	0.97
White, NH Females: Noncitizen	1.01	1.28	4.60	0.45	0.68	0.47
Black, NH Males: Citizen	0.96	0.57	0.34	1.45	1.56	0.57
Black, NH Males: Noncitizen	0.98	0.91	not reported			
Black, NH Females: Citizen	0.99	0.70	0.31	1.96	1.72	0.33
Black, NH Females: Noncitizen	0.92	0.75	not reported			
Hispanic, Males: Citizen	0.88	0.63	0.60	1.60	1.60	1.34
Hispanic, Males: Noncitizen	0.52	0.44	1.79	0.28	0.59	0.44
Hispanic, Females: Citizen	0.90	0.69	0.40	1.42	2.48	0.83
Hispanic, Females: Noncitizen	0.53	0.51	1.28	0.49	0.78	0.25
Asian, NH Males: Citizen	1.05	1.66	2.46	0.82	1.18	1.33
Asian, NH Males: Noncitizen	1.00	1.98	7.88	0.19	0.44	0.27
Asian, NH Females: Citizen	1.01	1.59	1.89	1.13	1.12	0.61
Asian, NH Females: Noncitizen	0.95	1.79	4.86	0.32	0.46	0.12
American Indian, NH Males: Citizen	0.94	0.47	not reported			
American Indian, NH Males: Noncitizen	0.86	1.07	not reported			
American Indian, NH Females: Citizen	0.96	0.55	not reported			
American Indian, NH Females: Noncitizen	0.88	0.91	not reported			