Activities, Productivity, and Compensation of Men and Women in the Life Sciences

Catherine M. DesRoches, DrPH, Darren E. Zinner, PhD, Sowmya R. Rao, PhD,
Lisa I. Iezzoni, MD, MSc, and Eric G. Campbell, PhD

Abstract

Purpose
To determine whether professional activities, professional productivity, and salaries of life sciences faculty differ by gender. The authors undertook this study because previous studies found differences in the academic experiences of women and men.

Method
In 2007, the authors conducted a mailed survey of 3,080 life sciences faculty at the 50 universities whose medical schools received the greatest amount of National Institutes of Health funding in 2004. The response rate was 74% (n = 2,168). The main outcome measures were a faculty member's total number of publications; number of publications in the past three years; average impact score of the journals in which he or she had published; professional activities; work hours per week; the numbers of hours spent specifically in teaching, patient care, research, professional activities, and administrative activities; and annual income.

Results
Among professors, the women reported greater numbers of hours worked per week and greater numbers of administrative and professional activities than did the men. Female faculty members reported fewer publications across all ranks. After control for professional characteristics and productivity, female researchers in the life sciences earned, on average, approximately $13,226 less annually than did their male counterparts.

Conclusions
Men and women in the academic life sciences take on different roles as they advance through their careers. A substantial salary gap still exists between men and women that cannot be explained by productivity or other professional factors. Compensation and advancement policies should recognize the full scope of the roles that female researchers play.

Acad Med. 2010; 85:631–639.

The number of women in the life sciences has increased markedly over the past four decades.[1,2] Nevertheless, women and men have very different academic experiences. Women advance in academic rank more slowly than do men, hold fewer leadership positions, and receive lower salaries.[3,4] However, women also work fewer hours in academic settings than do men, have fewer publications and research grants, and receive lower resource and space allocations.[2,5,6] Various factors may explain these differences, including women's generally greater role in balancing work and family responsibilities, a lack of effective mentors for women, women's different career choices, and discriminatory attitudes.[6–8]

Whereas prior studies such as those by Jagsi et al[2] and Ash et al[4] elucidated differences in academic rank and compensation between male and female researchers, they provided little information about gender differences in professional roles and activities and the effect of those differences on salary discrepancies. Furthermore, previous studies reached back many years, so a question remains as to whether earlier gender disparities still exist. To address these issues, we surveyed life sciences researchers in the 50 most research-intensive universities and medical centers in the United States. We considered three questions: (1) Do the professional activities of life sciences researchers differ by gender? (2) Does professional productivity of researchers still vary by gender? (3) After professional activities are accounted for, does salary differ by gender?

Method

Sample design

We surveyed life sciences researchers between January and March 2007, selecting the 3,080 respondents in three stages. First, we identified the 50 universities whose medical schools (or medical school affiliations) received the greatest amount of extramural funding from the National Institutes of Health (NIH) in 2004. Second, within these 50 institutions, we identified all departments and programs relating to life sciences and grouped them into four sampling strata: (1) departments of medicine, (2) other clinical departments (referred to below as "nonmedical clinical"), (3) life sciences departments without clinical programs

Dr. DesRoches is assistant in health policy, The Mongan Institute for Health Policy, Massachusetts General Hospital, Boston, Massachusetts, and assistant professor, Harvard Medical School, Boston, Massachusetts.

Dr. Zinner is senior research associate, The Health Industry Forum, and senior lecturer, Heller School of Social Policy & Management, Brandeis University, Waltham, Massachusetts.

Dr. Rao is assistant professor, Biostatistics Center, The Mongan Institute for Health Policy, Massachusetts General Hospital, Boston, Massachusetts, and assistant professor, Harvard Medical School, Boston, Massachusetts.

Dr. Iezzoni is associate director, The Mongan Institute for Health Policy, Massachusetts General Hospital, Boston, Massachusetts, and professor, Department of Medicine, Harvard Medical School, Boston, Massachusetts.

Dr. Campbell is director of research, The Mongan Institute for Health Policy, Massachusetts General Hospital, Boston, Massachusetts, and associate professor, Harvard Medical School, Boston, Massachusetts.

Correspondence should be addressed to Dr. DesRoches, Mongan Institute for Health Policy, Massachusetts General Hospital, 50 Staniford Street, Ninth Floor, Boston, MA 02114; telephone: (617) 724–6958; fax: (617) 724–4738; e-mail: cdesroches@partners.org.

(the nonclinical stratum), and (4) genetics programs. The nonmedical clinical stratum included departments receiving the highest amounts of NIH funding in 2003 (2004 departmental funding information was unavailable): anesthesiology, neurology, neurosurgery, obstetrics–gynecology, otolaryngology, pathology, pediatrics, psychiatry, radiation oncology, and surgery. The nonclinical stratum included anatomy/cell biology, biochemistry, microbiology, pharmacology, and physiology/biophysics; these programs were in medical schools or university graduate departments. To identify U.S. programs offering doctoral-level genetics training, we consulted *Peterson's Guide to Graduate Programs*.[9]

Finally, we selected at random 770 life sciences researchers from each of the four sampling strata, drawing their names and addresses from departmental Web sites and from the Association of American Medical Colleges Faculty Roster (for the clinical strata). To eliminate fellows and hospital staff who are not clinician–researchers, we sampled only those clinical researchers with at least one publication (other than a review article or a letter) that was listed in the National Library of Medicine Medline database from 2003 through 2005.

Survey design and administration

To develop our questionnaire, we revised a survey that had been administered to life sciences faculty in 1985[10] and 1995.[11] We conducted focus groups and in-depth interviews with scientists to identify new topics to add to this existing questionnaire. We refined the new survey questions by using cognitive testing, and we tested the entire survey with researchers who were randomly selected from the sampling frame. The final survey included 108 questions and took approximately 15 to 20 minutes to complete. The survey included three types of items: (1) items with multiple responses (e.g., "In the past three years, have you been a chair or an associate chair of your department, a university-wide administrator, a member of a review panel, an editor of a professional journal, a consultant to the government, a director or associate director of a research institute or center, a chair of a university-wide committee, an officer of a professional association, or a member of a board or review panel on a foundation?"), for which respondents were asked to check all that apply, (2) items with Likert scale-type responses (e.g., to a great extent, to some extent, very little, or not at all), and (3) items with yes/no responses. The survey also included items that required respondents to specify the number of hours spent in individual academic activities, the total amount of their grant funding, and the names of the last five journals in which they had publications.

The Center for Survey Research (CSR) at the University of Massachusetts–Boston administered the survey and asked each respondent to return the completed questionnaire in the return envelope (enclosed with the survey) and to mail, separately, the enclosed postcard, which included that respondent's identification number. To ensure the anonymity of responses, the identification numbers on postcards could not be linked with the completed surveys themselves; CSR conducted telephone follow-up with all individuals who did not return the postcard. Because of the small numbers of researchers in each rank-and-gender category at sampled institutions, information on department or specialty could potentially reveal individual identities; therefore, to further guarantee anonymity, we did not ask respondents to provide that information. The institutional review boards at Massachusetts General Hospital and the University of Massachusetts–Boston approved this study. We had complete independence in developing the survey, collecting and analyzing the data, and reporting the results.

Variables

We assessed academic productivity by examining each respondent's professional activities, total number of publications, number of publications in the past three years, and number of publications per year. We asked respondents to list the journals in which their last five peer-reviewed articles were published, and, using journal impact factors from the 2006 ISI Web of Science,[12] we averaged the impact factors for the five journals named by each respondent.

To explore professional activities, the survey asked respondents to indicate roles they had filled in the past three years. The roles listed were chair or associate chair of their department; university-wide administrator; member of a federal agency review panel or study section; editor or editorial board member of a professional journal; government consultant; director or associate director of a research institute or center; chair of a university-wide committee; officer of a professional association; or member of a foundation board or review panel.

The survey also gathered data on the total number of hours spent on professional activities during a typical workweek, including patient care, research, teaching, consulting, professional travel, writing, professional reading, and administration but excluding time on call when not actually working. The survey then asked respondents to specify the number of hours spent in each of the following activities: direct patient care, teaching, research, administration, and other professional activities outside of their institution. The number of hours spent in specific activities did not have to equal the total number of hours spent working.

We asked respondents to report their annual institutional salary, including income from clinical practice plans. To provide this information, they checked one of the following categories: under \$50,000; \$50,000 to \$74,999; \$75,000 to \$99,999; \$100,000 to \$149,999; \$150,000 to \$199,999; \$200,000 to \$299,999; \$300,000 to \$349,999; or \$350,000 or more.

Analysis

All data were weighted to adjust for differential nonresponse and probability of selection within sampling strata. Because institutions vary significantly in the use of the rank of "instructor," our analysis considered only researchers at the level of assistant professor or higher. All data analysis was conducted by researchers at Massachusetts General Hospital and Brandeis University.

To determine whether men and women differed in number of hours worked, amount of time spent in various professional activities, and productivity, we ran separate multivariate regressions for each measure. We stratified regressions by academic rank and controlled for the number of years in the profession, race, ethnicity, and the type of department that a respondent worked in—clinical or basic research.

We used linear regression and ordered logistic regression to explore associations of gender with income after we controlled for race, ethnicity, academic rank, department (i.e., survey stratum), provision of patient care, research budget, professional service acts, the number of hours worked, and the average impact factor of journals in which a respondent published. To assess their total research budgets, respondents were asked two questions. First we asked, "What is the total budget this fiscal year for grants and contracts from any source on which you are the principal investigator (PI)? (please exclude overhead/indirect costs)." Then we asked, "What is the total budget this fiscal year for grants and contracts from any source on which you are the co-PI? (please exclude overhead/indirect costs)." These questions were used to create a total research budget variable. Because the variable is not normally distributed, we included the log of this amount in the multivariate regression.

The income analysis excludes faculty in nonmedical clinical departments. As stated above, in light of concerns for confidentiality, we did not collect data on respondents' specialties. Because any income differences found among this group are likely to be strongly influenced by specialty choice, we excluded them from the income analysis.

In addition to our standard regression analysis, we used the Peters–Belson regression method to examine observed differences in income between male and female faculty. This approach partitions the observed disparity into a portion that is "explained" by the covariates in the model and a portion that is "unexplained" by the same covariates. Wage discrimination studies have used Peters–Belson regression to estimate the incomes that women would have if they were men, by first fitting the regression for men and then estimating individual women's salaries by controlling for their covariates in this model.[13–15]

To estimate the magnitude of salary differences, we used a standard labor economics technique, assigning each respondent the midpoint of his or her salary category for the lowest seven groupings; for example, respondents reporting annual incomes of $100,000 to $150,000 were assigned values of $125,000.[16,17] This strategy allowed us to turn categorical values into continuous values. For the highest category (incomes ≥ $350,000), we set income equal to $350,000 and included a separate dummy variable for these cases (4.6% of the total) in our linear regressions. This approach limited potential distortions caused by upper-income outliers, and it constrained overall variation. Thus, differences across groups must be sufficiently strong to affect the general size of income categories. All regression methods produced robust and equivalent findings. For brevity, we present only the results of the general linear regression and the Peters–Belson regression. We conducted all analyses by using SAS statistical software (version 9.1; SAS Institute, Cary, North Carolina).

Results

Response rates

Of 3,080 researchers in the sample, 139 were ineligible because they had died or retired, no longer held faculty appointments, or could not be located. Of the remaining 2,941 researchers, 2,168 completed the survey, for an overall response rate of 74%. Response rates were 72% among subjects in clinical departments and 75% in nonclinical departments.[18]

Respondents were predominantly male and white; 971 (44.8%) were full professors, and 568 (26.2%) were associate professors (Table 1). Nearly two-thirds (62%) held PhDs. Approximately 87% had worked in the life sciences for 10 years or more and had annual incomes of at least $100,000. Female respondents were less likely than male respondents to hold the rank of professor, and they were significantly more likely to work in clinical departments. Female respondents reported fewer years as faculty than did male respondents: 60% of male respondents reported having been faculty members for 20 years or more, compared with only 42% of female respondents.

Hours and activities

Among full professors, the women reported working significantly more hours per week than did the men after adjustment for number of years in the profession, race, ethnicity, and affiliation with a clinical or basic science department (Table 2). The women and the men reported that they spent an approximately equal number of hours in performing research, patient care, and teaching, whereas the women reported that they spent significantly more hours than did the men in performing administrative tasks and other professional activities. Weekly work hours and activities did not differ by gender among associate professors.

Among assistant professors, the women reported working significantly fewer hours per week than did the men (Table 2). Female and male assistant professors reported spending an approximately equal number of hours in patient care, teaching, administrative tasks, and other professional activities, after adjustment for demographic and professional characteristics. However, the women reported spending significantly fewer hours in research than did the men.

Productivity

Table 3 presents measures of professional productivity. After adjustment for demographic and professional characteristics, female full professors reported significantly fewer total publications than did male full professors. Several male outliers (those with more than 500 publications over lengthy careers) strongly affected this 40-publication spread of mean values. The male respondents had a median total of 100 (data not shown) publications, whereas the female respondents had a median total of 84 publications.

Among associate professors, the women reported significantly fewer total publications than the men and a significantly smaller number of publications in the past three years. Assistant professors displayed a similar pattern for total publications.

We asked respondents to report on nine professional service activities. Table 4 presents findings from full professors only (they accounted for 65.8% of reported activities). Of these nine activities, female full professors were significantly more likely to report five: university administrator, member of federal review panel, journal editor or editorial board member, chair of university-wide committee, and officer of professional association. Female professors were almost twice as likely as

Table 1

Characteristics of 2,168 Faculty Researchers in the Life Sciences in the 50 U.S. Institutions Receiving the Highest Amounts of NIH Funding in 2004*

Variable	All faculty, unweighted no.	Respondents, weighted no. (%)			*P* value
		All†	Men‡	Women‡	
Total	2,168	2,168 (100)	1,549 (71.4)	593 (27.3)	
Academic rank					
Full professor	962	971 (44.8)	790 (51.0)	174 (29.3)	<.001§
Associate professor	563	568 (26.2)	395 (25.5)	165 (27.8)	
Assistant professor	561	566 (26.1)	338 (21.8)	219 (37.0)	
Other	63	63 (2.9)	28 (1.8)	35 (6.0)	
Degree held¶					
MD	991	999 (46.1)	745 (48.1)	244 (41.2)	.005‖
PhD	1,333	1,344 (62.0)	965 (62.3)	362 (61.0)	.588
Other doctorate	43	43 (2.0)	29 (1.8)	15 (2.6)	.283
Time in profession, years					
0–5	32	33 (1.5)	20 (1.3)	12 (2.0)	<.001§
6–10	235	238 (11.0)	142 (9.2)	92 (15.5)	
11–20	685	694 (32.0)	449 (29.0)	239 (40.3)	
21–30	675	685 (31.6)	505 (32.6)	173 (29.2)	
31–40	370	375 (17.3)	308 (19.9)	60 (10.1)	
>40	142	143 (6.6)	124 (8.0)	17 (2.9)	
Race/ethnicity					
African American	22	21.8 (1.0)	123 (0.8)	9 (1.5)	.164
Asian	314	319 (14.7)	226 (14.6)	89 (15.1)	.755
White	1,705	1,734 (80.0)	1,242 (80.2)	475 (80.1)	.992
Other	47	48 (2.2)	34 (2.2)	13 (2.2)	.994
Declined to report	57	58 (2.7)	45 (2.9)	10 (1.7)	.110
Hispanic, any race	56	56 (2.6)	40 (2.6)	21 (3.6)	.101
Annual salary					
<$50,000	35	37 (1.7)	22 (1.4)	14 (2.4)	<.001§
$50,000–$74,999	166	171 (7.9)	90 (5.8)	78 (13.2)	
$75,000–$99,999	453	364 (16.9)	223 (14.4)	137 (23.2)	
$100,000–$149,999	596	615 (28.4)	434 (28.0)	172 (29.5)	
$150,000–$199,999	471	492 (22.5)	378 (24.4)	105 (17.7)	
$200,000–$249,999	244	251 (11.6)	203 (13.1)	48 (8.1)	
$250,000–$299,999	113	118 (5.4)	91 (5.9)	24 (4.1)	
$300,000–$349,999	50	52 (2.4)	45 (2.9)	6 (1.0)	
≥$350,000	67	69 (3.2)	64 (4.1)	5 (0.9)	
Mean imputed salary (overall: $154,974)			$163,837	$132,719	<.001
Survey strata					
Department of medicine	518	518 (23.9)	383 (24.7)	128 (21.6)	.001‖
Other clinical department	553	552 (25.5)	345 (22.3)	200 (33.7)	
Nonclinical life sciences department	556	557 (25.7)	413 (26.7)	135 (22.8)	
Genetics program	541	542 (25.0)	407 (26.3)	130 (21.9)	

* NIH indicates National Institutes of Health. All data were weighted to adjust for differential nonresponse and probability of selection within the four sampling strata.
† The numbers may not sum to 2,168 because of missing data.
‡ The percentages may not total 100% because of rounding.
§ Significant difference between the distribution of men and women across all levels of the categorical variable; values obtained by using a chi-square test.
¶ The percentages do not total 100% because some respondents had multiple degrees.
‖ Significant difference between men and women; values obtained by using a test of difference of proportions within the row.

Table 2

The Number of Hours Spent at Work by Rank and Gender Among 2,186 Faculty in the Life Sciences in the 50 U.S. Universities Receiving the Highest Amounts of NIH Funding in 2004*

		Hours worked per week					
Variable	Weighted no. (% of faculty group)	Total	Research	Patient care†	Teaching	Administrative	Other professional activities
Professor, no.		57.6‡	24.8‡	15.1‡	8.5	11.0‡	4.8‡
Men, no.	783 (81.9)	56.8	24.6	15.5	8.2	10.4	4.4
Women, no.	172 (18.1)	60.9	24.7	13.7	9.8	13.7	6.6
P values for difference between men and women		.05	.63	.41	.07	.02	<.001
Associate professor, no.		55.9§	21.8	19.6	8.6	8.1§	3.5¶
Men, no.	391 (68.7)	54.7	22.1	19.5	8.1	7.7	3.3
Women, no.	163 (31.3)	57.8	21.6	18.9	9.5	9.1	3.9
P values for difference between men and women		.18	.74	.78	.13	.20	.18
Assistant professor, no.		52.8	24.7	17.5	7.7	5.5	2.1
Men, no.	335 (55.8)	55.3	26.7	18.2	7.3	5.7	2.3
Women, no.	217 (44.2)	49.9	21.9	16.7	8.3	5.3	1.9
P values for difference between men and women		<.001	.04	.46	.21	.34	.20

* NIH indicates National Institutes of Health. Values were obtained by using a multivariable linear regression to control for differences due to the number of years in profession, race/ethnicity, or appointment in a clinical or basic research department.
† Clinical departments only.
‡ The difference between full and associate professors was significant at $P \leq .01$.
§ The difference between associate and assistant professors was significant at $P \leq .05$.
¶ The difference between associate and assistant professors was significant at $P \leq .02$.

males to report having four or more professional roles in the past three years.

Institutional salary

Table 5 shows the results of the regression analyses predicting self-reported annual institutional salary for all faculty except those in nonmedical clinical departments. A higher academic rank, the respondent's department (i.e., survey strata), the provision of patient care, the number of professional service acts, the number of hours worked per week, the average impact factor of journals in which the respondent published, and male gender had significant positive associations with institutional salary. After control for all independent variables, female faculty members reported salaries that were, on average, $13,228 lower than those of comparable males ($P < .001$). Although this difference represents an estimate based on transforming categorical survey responses into continuous values, multiple alternative regression specifications confirmed this statistically significant difference. When we used the Peters–Belson regression method and controlled for all covariates, the average expected salary for female respondents ($140,854) was significantly higher than the average observed salary ($128,208). The covariates in the model explained 61.8% of this disparity.

Sensitivity analysis suggested that this income differential varied somewhat by broad category of life sciences researchers. For example, the salaries of male respondents with PhDs were $6,028 higher than those of female respondents with PhDs ($P = .05$); male researchers not providing patient care earned $7,832 more than did comparable female researchers ($P = .01$). Finally, male respondents in departments of medicine had salaries $14,868 higher than their female counterparts ($P = .01$). We repeated the Peters–Belson regression analysis within each of the analytic groups and found that the expected salary for female faculty members was, again, significantly higher than the observed salary across the three groups (PhDs: expected salary, $118,875; observed salary, $113,286; nonpatient care: expected salary, $120,578; observed salary, $112,450; department of medicine: expected salary, $146,872; observed salary, $133,218). The covariates in the model explained 66.3%, 66.3%, and 68.0% of these disparities, respectively.

We repeated the regression models interacting gender with type of degree and with academic rank to estimate whether gender–income differentials remained consistent across types and stages of careers. With control for all independent variables, these models estimated that, overall, female assistant professors were paid, on average, $21,600 less than were their male counterparts ($P < .01$). The mean difference was $8,500 for associate professors ($P = .12$) and $13,700 for full professors ($P = .02$). MD–PhDs and MDs made $34,000 and $49,000 more than did PhDs overall ($P <$ .01 for both comparisons), and female researchers garnered less income regardless of their earned degree (MD: −$14,400, $P = .03$; PhD: −$8,400, $P <$ .01), although this relationship was not

Table 3

Academic Productivity by Rank and Gender Among 2,186 Faculty in the Life Sciences in the 50 U.S. Universities Receiving the Highest Amounts of NIH Funding in 2004*

Variable	Unweighted no.	Mean total publications	Mean publications in the past three years	Mean journal impact factor score	Mean professional service activities†
Professor					
Men, no.	783	127.8	15.6	6.5	2.6
Women, no.	172	84.8	13.3	5.7	3.1
P values for difference between men and women		<.00	.01	.05	.01
Associate professor					
Men, no.	391	40.9	10.2	5.6	1.3
Women, no.	163	32.3	8.5	5.1	1.6
P values for difference between men and women		.02	.01	0.35	.16
Assistant professor					
Men, no.	335	19.1	6.4	5.9	0.6
Women, no.		14.7	5.9	5.7	0.5
P values for difference between men and women		.01	.37	.81	.35

* NIH indicates National Institutes of Health. Values were obtained by using a multivariable linear regression to control for differences due to the number of years in profession, race/ethnicity, and appointment in a clinical or basic research department.

† Professional service activities included serving as chair or associate chair of a department, university-wide administrator, member of a federal review panel or study section, journal editor or editorial board member, consultant to the government, director or associate director of a research institute or center, chair of a university-wide committee, officer of a professional association, and member of a board or review panel of a foundation.

significant for those with MD–PhD degrees (−$9,800, $P = .47$).

Discussion

Compensation and academic advancement in life sciences research depend largely on research productivity, which is partially gauged by the publication of original research. Our national survey found that female researchers of all ranks produced fewer publications than did their male counterparts. Nonetheless, even after we accounted for differences in publications, personal attributes, and other professional activities, female researchers still had annual salaries that were approximately $6,000 to $15,000 less than those of their male counterparts.

Although some may perceive these discrepancies as modest, the cumulative disparity over an academic career is substantial. During 30 years, for example, an average female faculty member with a PhD would earn $214,470 less than would a comparable male faculty member. If this annual deficit were invested in retirement accounts that grew by 6% annually, the total difference would approach $700,000; for department of medicine faculty, it would approach $1.3 million dollars. Moving forward, with increasing numbers of female researchers reaching professional heights, it is critical to monitor compensation differentials and not to assume that the growing prominence of women means that salary inequity is resolved.

Our survey demonstrated that, especially once they become full professors, men and women have somewhat different jobs. Compared with male full professors, female full professors worked more hours overall and spent significantly more time in administrative and professional activities and less time conducting research. Given the relatively small number of female full professors, the greater time spent on professional and other administrative roles could reflect efforts of institutions to increase the diversity of the individuals filling those roles. Female professors may feel compelled to accept these invitations, perhaps to serve as trailblazers or to fulfill some personal goal, but the possible consequence is that these activities are expanding the women's working hours.

At the other end of the academic ladder, the picture looks somewhat different. Among the junior ranks, the women spent fewer hours working per week—particularly in research—than did the men. This difference might explain the lower total number of publications by female faculty found in our survey as well as the smaller numbers of grant applications by female faculty that have been detected in other studies.[5,19–21] Self-perpetuating cycles could ensue, in which lower external funding provides less support for research time and less opportunity to produce publications, which then leads to fewer successful grant applications and lower funding. This cycle could exacerbate disparities between men and women in the amount of time they have for research.

Table 4

Professional Activities by Gender Among 962 Full Professors in the Life Sciences at the 50 U.S. Universities Receiving the Highest Amounts of NIH Funding in 2004*

Variable	Full professors: No. (%) Men (n = 790)	Women (n = 172)	*P* value
Roles			
Chair or associate chair of a department	198 (24.9)	36 (20.8)	.38
University-wide administrator	53 (6.7)	22 (13.1)	.03†
Member of review panel or study section for a federal agency	438 (55.4)	114 (66.5)	.05†
Journal editor or editorial board member	467 (59.1)	121 (70.5)	.04†
Consultant to government	211 (26.7)	51 (29.5)	.56
Director or associate director of a research institute or center	103 (13.0)	24 (13.8)	.84
Chair of a university-wide committee	146 (18.5)	48 (28.1)	.03†
Officer of a professional association	208 (26.4)	63 (36.7)	.04†
Member of a board or review panel of a foundation	223 (28.3)	56 (32.7)	.38
Total number of roles			
0	89 (11.3)	8 (4.6)	.02‡
1	127 (16.1)	21 (12.3)	
2	185 (23.4)	42 (24.6)	
3	175 (22.2)	28 (16.3)	
≥4	214 (27.1)	72 (42.2)	
Mean no. of roles	2.59	3.12	<.001

* NIH indicates National Institutes of Health.
† Significant difference between men and women, obtained by using a test of difference of proportions within the table row.
‡ Significant difference between the distribution of men and women across all levels of the categorical variable, obtained by using a chi-square test.

Our study had important limitations. We did not confirm salary levels, relying on anonymous self-reports. We asked respondents to report on one time period or to recall experiences over the past three years. Although this strategy could produce recall bias, women and men are unlikely to differ systematically in their recall. To protect respondent anonymity, we did not ask respondents to identify their specialty, and therefore we cannot assess how that factor affects annual compensation. Nonetheless, we found gender salary differentials in three different analytic groups: PhDs, nonclinicians, and department of medicine researchers. Thus, specialty choice is unlikely to completely explain salary discrepancies by gender. As a further protection of respondent anonymity, we did not obtain data on the regional locations of the respondents. Therefore, we cannot exclude the possibility that a portion of the salary differential could be due to regional variations in salary. Finally, our study did not ask about intangible benefits from professional activities, career satisfaction, or perceptions of workplace discrimination. Therefore, we cannot report how the female professors felt about their jobs and their salaries or whether they perceived differences in job status between themselves and their male colleagues.

Our survey selected a very specific subset of life sciences researchers—those at the institutions (and departments) receiving the largest amounts of NIH funding in the country. Because we aimed to survey researchers, we included only individuals who had published at least one journal article. This strategy meant that, for the clinical sample, we excluded 36.6% of researchers from medicine departments and 41.7% of those from other clinical departments. Furthermore, we excluded departments that were not heavily involved in NIH research and institutions without medical schools or medical school affiliations (e.g., Massachusetts Institute of Technology). Researchers at other types of institutions—or those with lower portfolios of NIH grants—might have different experiences. It is possible that the income disparity between men and women may be narrower in institutions that are less focused on research. Nevertheless, given the sampling design and high response rate, we believe that our study validly represents life sciences researchers who are conducting most of the federally funded, peer-reviewed research in the United States.

Our findings confirm and extend earlier work on differential compensation between men and women in the academic life sciences. Nonetheless, our data do not identify the source of these differences. Given the improbability that women would voluntarily choose to be paid less than men for comparable work, other forces must be at play. As elsewhere in society, these discrepancies could reflect historical practices, perhaps including sexist or otherwise disparaging attitudes about the contributions of women scientists, or they may reflect the different choices made by female researchers. For example, female physicians may choose to go into lower-paying specialties, for various reasons. Our findings also suggest that men and women in the academic life sciences take

Table 5

Multivariate Regression to Identify Individual Predictors of Income Among Faculty in the Life Sciences at the 50 U.S. Universities Receiving the Highest Amounts of NIH Funding in 2004*

Variable	All faculty: Income difference estimate	All faculty: *P* value	PhDs only: Income difference estimate	PhDs only: *P* value	Faculty not providing patient care: Income difference estimate	Faculty not providing patient care: *P* value	Department of medicine faculty: Income difference estimate	Department of medicine faculty: *P* value
Individual characteristics								
Gender								
● Men	(ref)		(ref)		(ref)		(ref)	
● Women	−$13,228	.00	−$6,028	.01	−$7,832	.01	−$14,868	.01
Race/ethnicity								
● White	(ref)		(ref)		(ref)	(ref)	(ref)	(ref)
● Asian	−$5,130	.15	$634	.85	−$2,874	.37	−$5,587	.35
● Black	$5,059	.72	−$14,589	.03	−$15,945	.01	$15,316	.40
● Other	$11,666	.42	−$3,399	.62	−$6,768	.32	$30,491	.20
● Hispanic, any race	$5,495	.50	−$2,283	.65	−$351	.95	$8,465	.48
Professional characteristics								
Rank								
● Full professor	(ref)		(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
● Associate professor	−$33,433	.00	−$38,677	.00	−$43,934	.00	−$26,333	.00
● Assistant professor	−$54,214	.00	−$55,280	.00	−$60,537	.00	−$55,024	.00
Strata†								
● Department of medicine	(ref)		(ref)	(ref)	(ref)	(ref)	NA	
● Nonclinical life sciences department	−$25,757	.00	−$5,072	.23	−$9,825	.03	NA	
● Genetics program	−$22,984	.00	−$6,260	.16	−$11,164	.02	NA	
Patient-care responsibilities								
● Does not provide patient care	(ref)		(ref)				(ref)	
● Provides patient care	$13,855	.02	−$2,400	.07	NA		$13,602	.10
Research activities/productivity								
Total grant funding (log)	$195	.65	$860	.03	$732	.12	−$340	.56
Total number of professional service acts	$7,377	.00	$10,145	.00	$9,841	.00	$4,981	.01
Total number of hours worked per week	$725	.00	$183	.15	$368	.01	$1,205	.00
Average journal impact factor	$898	.02	$1,971	.00	$1,611	.00	$331	.54
Amount of variance explained by the model		0.5489		0.5349		0.5811		0.5552

* NIH indicates National Institutes of Health. Values were obtained by using a multivariable linear regression to control for all variables shown in the table.
† Nonmedical clinical departments were excluded from this analysis.

on different roles as they advance through their careers. Finally, our findings show that, despite increased national attention to gender inequalities in salary, women in the life sciences at all academic ranks, both PhDs and MDs, continued in 2007 to receive lower annual salaries than did their male counterparts. Compensation and advancement policies should recognize and reward the full scope of the roles that women researchers play as they advance in their careers and contribute to life sciences research.

Funding/Support: Funding for this study was provided by the National Institutes of Health, Human Genome Project, under grant no. 5R01GM074915–02.

Other disclosures: None.

Ethical approval: Granted by the institutional review boards of Massachusetts General Hospital and the University of Massachusetts–Boston.

Disclaimer: The NIH Human Genome Project had no role in the conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

References

1 Association of American Medical Colleges. Women in U.S. Academic Medicine: Statistics and Medical School Benchmarking. Washington, DC: Association of American Medical Colleges; 2005.

2 Jagsi R, Guancial EA, Worobey CC, et al. The "gender gap" in authorship of academic medical literature—A 35-year perspective. N Engl J Med. 2006;355:281–287.

3 Nonnemaker L. Women physicians in academic medicine: New insights from cohort studies. N Engl J Med. 2000;342:399–405.

4 Ash AS, Carr PL, Goldstein R, Friedman RH. Compensation and advancement of women in academic medicine: Is there equity? Ann Intern Med. 2004;141:205–212.

5 Waisbren SE, Bowles H, Hasan T, et al. Gender differences in research grant applications and funding outcomes for medical school faculty. J Womens Health (Larchmt). 2008;17:207–214.

6 Massachusetts Institute of Technology. A study on the status of women faculty in science at MIT. Available at: http://web.mit.edu/fnl/women/women.html#The%20Study. Accessed January 4, 2010.

7 Dorsey ER, Jarjoura D, Rutecki GW. The influence of controllable lifestyle and sex on the specialty choices of graduating U.S. medical students, 1996–2003. Acad Med. 2005;80:791–796.

8 Yedidia MJ, Bickel J. Why aren't there more women leaders in academic medicine? The views of clinical department chairs. Acad Med. 2001;76:453–465.

9 Peterson's Guide to Graduate Programs. Available at: http://www.petersons.com/graduate_home.asp?path=gr.home. Accessed January 4, 2010.

10 Blumenthal D, Gluck M, Louis KS, Stoto MA, Wise D. University–industry research relationships in biotechnology: Implications for the university. Science. 1986;232:1361–1366.

11 Blumenthal D, Campbell EG, Causino N, Louis KS. Participation of life-science faculty in research relationships with industry. N Engl J Med. 1996;335:1734–1739.

12 Thomson Scientific ISI Web of Science. Available at: http://isiwebofknowledge.com. Accessed January 4, 2010.

13 Oaxaca R. Male–female wage differentials in urban labor markets. Int Econ Rev (Philadelphia). 1973;14:693–709.

14 Blinder A. Wage discrimination: Reduced form and structural estimates. J Hum Resour. 1973;8:436–455.

15 Goldin C. Understanding the Gender Gap: An Economic History of American Women. New York, NY: Oxford University Press; 1990.

16 McLaughlin SD. Occupational sex identification and the assessment of male and female earnings inequality. Am Sociol Rev. 1978;43:909–921.

17 Parker RN, Fenwick R. The pareto curve and its utility for open-ended income distributions in survey research. Soc Forces. 1983;61:872–885.

18 The American Association for Public Opinion Research. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. Available at: http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions1&Template=/CM/ContentDisplay.cfm&ContentID=1814. Accessed January 4, 2010.

19 Blake M, La Valle I. Who applies for research funding? Key Factors Shaping Funding Application Behaviour Among Women and Men in British Higher Education Institutions. London, UK: Wellcome Trust; 2000.

20 Breithaupt H. Losing them is not an option. EMBO Rep. 2001;2:651–655.

21 National Academy of Sciences; National Academy of Engineering; Institute of Medicine. Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering. Washington, DC: National Academies Press; 2006.