SPECIAL ARTICLE

Women Physicians and Promotion in Academic Medicine

Kimber P. Richter, Ph.D., M.P.H., Lauren Clark, M.S., Jo A. Wick, Ph.D., Erica Cruvinel, Ph.D., Dianne Durham, Ph.D., Pamela Shaw, M.D., Grace H. Shih, M.D., Christie A. Befort, Ph.D., and Robert D. Simari, M.D.

ABSTRACT

BACKGROUND

In 2000, a landmark study showed that women who graduated from U.S. medical schools from 1979 through 1997 were less likely than their male counterparts to be promoted to upper faculty ranks in academic medical centers. It is unclear whether these differences persist.

METHODS

We merged data from the Association of American Medical Colleges on all medical school graduates from 1979 through 2013 with faculty data through 2018, and we compared the percentages of women who would be expected to be promoted on the basis of the proportion of women in the graduating class with the actual percentages of women who were promoted. We calculated Kaplan–Meier curves and used adjusted Cox proportional-hazards models to examine the differences between the early cohorts (1979–1997) and the late cohorts (1998–2013).

RESULTS

The sample included 559,098 graduates from 134 U.S. medical schools. In most of the cohorts, fewer women than expected were promoted to the rank of associate or full professor or appointed to the post of department chair. Findings were similar across basic science and clinical departments. In analyses that included all the cohorts, after adjustment for graduation year, race or ethnic group, and department type, women assistant professors were less likely than their male counterparts to be promoted to associate professor (hazard ratio, 0.76; 95% confidence interval [CI], 0.74 to 0.78). Similar sex disparities existed in promotions to full professor (hazard ratio, 0.77; 95% CI, 0.74 to 0.81) and appointments to department chair (hazard ratio, 0.46; 95% CI, 0.39 to 0.54). These sex differences in promotions and appointments did not diminish over time and were not smaller in the later cohorts than in the earlier cohorts. The sex differences were even larger in the later cohorts with respect to promotion to full professor.

CONCLUSIONS

Over a 35-year period, women physicians in academic medical centers were less likely than men to be promoted to the rank of associate or full professor or to be appointed to department chair, and there was no apparent narrowing in the gap over time. (Funded by the University of Kansas Medical Center Joy McCann Professorship for Women in Medicine and the American Association of University Women.)

From the Departments of Population Health (K.P.R., E.C., C.A.B.), Biostatistics and Data Science (L.C., J.A.W.), Otolaryngology and Head and Neck Surgery (D.D.), Pediatrics (P.S.), Anesthesiology (G.H.S.), and Cardiovascular Medicine (R.D.S.), University of Kansas School of Medicine, Kansas City. Address reprint requests to Dr. Richter at the Department of Population Health, University of Kansas Medical Center, 3901 Rainbow Blvd., Kansas City, KS 66160-7313, or at krichter@kumc.edu.

N Engl J Med 2020;383:2148-57.
DOI: 10.1056/NEJMsa1916935

Twenty years ago, a landmark longitudinal cohort study showed that the percentage of women physicians at U.S. medical schools who were advancing in rank to associate or full professor was lower than expected on the basis of parity between men and women.[1] Since then, a number of studies have focused on the promotion gap. A cross-sectional study conducted in 2014[2] showed that sex disparity with respect to promotion remained even after accounting for age, experience, specialty, and research productivity.

As of 2014, 38% of full-time medical school faculty members, but only 21% of full professors and 15% of department chairs, were women physicians.[3] This finding suggests that progress has been made, since the original cohort study[1] showed that only 10% of full professors in 1979 were women. However, this increase could be attributable to disproportionately large numbers of women entering academic medicine as assistant professors. Most studies have not evaluated whether women are promoted at the same pace as men.

The original study controlled for cohort effects by using graduating medical classes to set expectations regarding the proportion of women who should have been promoted to assistant, associate, and full professor positions. In the current study, we pooled data from 35 years of medical school classes to determine whether the actual percentage of women physicians who were promoted matched the expected percentages, whether differences persisted after adjustment for potential confounders, and whether the promotion gap has been closed in more recent cohorts. Twenty years after the original study, we were able to provide important updates regarding the promotion of women in the original 1979–1997 cohorts, and we evaluated sex differences with respect to appointment to the leadership position of department chair.

Methods

Data Sources and Study Sample

The Association of American Medical Colleges (AAMC) Student Records System includes data on every graduate of medical doctorate degree–granting schools in the United States. Information on every full-time faculty or department chair position ever held by a graduate of one of these medical schools is available. The roster data for this study were based on a July 31, 2018, snapshot. We merged data into a single file containing information on 559,098 persons who graduated from 134 U.S. medical schools in the academic years 1978–1979 through 2012–2013.

Study Measures

Our main outcome measures were full-time faculty appointments at the level of assistant, associate, or full professor, and department chair. Assistant professor is the entry-level rank for full-time, permanent faculty at most medical schools. An advancement in rank was considered to be a promotion regardless of whether it was an internal advancement or a move to another institution. Data on specific types of faculty tracks (e.g., clinician, educator, or researcher) were not available. We also did not have information about tenure status, since many medical schools no longer grant tenure.[4] Data on appointments included the medical school (code number), department, rank, and first and last years of the appointment. A total of 35 cohorts of medical school graduates were created according to the year of graduation (spanning academic years 1978–1979 through 2012–2013). Available demographic data were the graduation year and the sex and race or ethnic group reported by the graduates.

Statistical Analysis

To replicate the previous analysis,[1] we calculated the actual and expected numbers of women who were promoted to each rank. The expected number was the number of women who would have achieved a given rank under conditions of parity between women and men on the basis of their representation in a given graduation cohort. To create a 4-year time buffer between graduation and faculty appointment, we excluded the cohorts from academic years 2013–2014 onward from our analyses. For the analysis of appointment to department chair, we included all the faculty members who were associate professors or full professors.

For each medical school graduating cohort and for all the cohorts combined, we calculated the difference between the actual and expected percentages of women who were promoted or

appointed as well as the corresponding 95% exact binomial confidence interval. For example, for assistant professors in a given medical school cohort, we determined the number of graduates who had ever been appointed as assistant professor and the percentage of those appointed who were women. We then determined the percentage that would be expected if the percentage had reflected the proportion of women in the graduating class. We subtracted the expected percentage from the actual percentage to assess whether the sex mix of the persons appointed matched the sex mix of the original medical school cohort. We graphed these differences to depict trends. For promotion to associate professor, we determined the number of graduates from a given cohort who had ever been assistant professors. We then determined whether the sex mix of those persons who had ever been promoted to associate professor matched the sex mix of those who had ever been appointed to assistant professor. For promotion to full professor, we compared the sex mix of those persons who had ever been appointed as associate professor with the sex mix of those who had ever been appointed as full professor. For the analysis of promotion according to academic department, we excluded 5717 faculty members (32.2% of whom were women) who switched departments over the course of their careers and 130 faculty members with appointments in departments that were classified as being neither clinical nor basic science.

Because the analyses were descriptive, confidence intervals were not adjusted for multiplicity. All data were complete except for data on 1363 of 559,098 faculty members (0.24%) for whom information about race or ethnic group was missing; these persons were assigned to the category "other race or ethnic group, multiracial non-Hispanic, or unknown."

We used nonparametric Kaplan–Meier curves to depict promotion in a time-to-event analysis according to sex and rank across all study cohorts (1979–2013) and between the original (1979–1997) and later (1998–2013) cohorts. We excluded from the analyses 9052 graduates (1.6%) who skipped a rank; 7256 of these graduates skipped a rank because their first faculty appointment skipped the rank of assistant professor.

We used three criteria to censor data on individual physicians. First, because unequal follow-up between the original and later cohorts could potentially bias findings, we imposed a censoring criterion that was based on the duration of follow-up in the later cohort. We identified the maximum observed time to event (promotion or censoring) for a graduate of the later class cohorts (1998–2013). We censored data on all the individual physicians from the early and late cohorts at that time. Data were censored at 7359 days for appointment to assistant professor, 7358 days for promotion to associate professor, 5029 days for promotion to full professor, and 5029 days for appointment to department chair. Second, to account for attrition from academic medicine, we censored data on individual physicians who took a lengthy hiatus from or left academic medicine, as indicated by a gap of 3 years or more between appointments in the AAMC Faculty Roster. Third, data on all faculty members who had not been promoted within the study time period (by July 31, 2018, the last follow-up date for AAMC Faculty Roster data), were right-censored. The percentages of all graduates appointed to assistant professor, all assistant professors promoted to associate professor, all associate professors promoted to full professor, and all associate and full professors appointed to department chair were computed separately for men and women.

We estimated differences between sexes in the average probability of promotion with the use of two sets of Cox proportional-hazards models. The first set of models used the censoring criteria as described above and estimated the probability of promotion or appointment across all cohort years (1979–2013), with adjustment for year of graduation, race or ethnic group, and department type (if applicable). The second set of models included sex, race or ethnic group, department type (for the ranks of associate professor, full professor, and department chair), a dichotomous variable splitting the cohort according to graduation year into early (1979–1997) and late (1998–2013) groups, and an interaction term between sex and early or late graduation. The interaction term allowed us to examine changes in sex effects between the original cohorts included in the 2000 landmark article and the later cohorts added in this study.

We then conducted sensitivity analyses with a third and fourth set of models. The third set of

models involved the use of sensitivity analyses to examine whether delays in promotion or appointment contributed to sex differences in promotion or appointment; in one analysis, faculty members had to remain in rank for 3.5 years, and in the other analysis, faculty members had to remain in rank for 7.0 years before being included in the analysis. In this set of models, we also examined the effect of including only full professors in the analysis of appointment to department chair. In the fourth set of models, we examined the effect of censoring by varying the first censoring criterion to no censoring and by censoring data on graduates and faculty members at the time at which 75% of all those who achieved promotion or appointment had been promoted or appointed. We conducted analyses with the use of SAS software, version 9.4.23 (SAS Institute).[5]

RESULTS

Our sample consisted of 559,098 medical school graduates. Women accounted for 38.9% of the graduates and 40.8% of the assistant professors; these data indicate that women were slightly more likely to choose a career in academic medicine than men. Women graduates were more diverse than male graduates; 33.3% of the women and 24.4% of the men were in racial or ethnic minority groups.

UNADJUSTED COHORT ANALYSES

In 34 of 35 cohorts of medical school graduating classes, more women than expected became assistant professors at some point after graduation (see Fig. S1 and Table S1 in the Supplementary Appendix, available with the full text of this article at NEJM.org). In 32 of 35 medical school graduating cohorts, fewer female assistant professors than expected were promoted to associate professor (Fig. 1A and Table S2). The absolute difference between the actual and expected promotions in all the cohorts together was 8.7 percentage points (95% confidence interval [CI], 8.3 to 9.2).

In 28 of 35 cohorts, fewer female associate professors than expected were promoted to full professor (Fig. 1B and Table S3). The absolute difference between actual and expected promotions in all the cohorts together was 6.6 percentage points (95% CI, 6.0 to 7.3).

In 30 of 35 cohorts, fewer women than expected were appointed to lead a department as chair (Fig. 1C and Table S4). The absolute difference between actual and expected appointments in the cohorts combined was 14.4 percentage points (95% CI, 12.9 to 15.8).

Among all the cohorts, the percentages of women graduates who were promoted to associate or full professor were lower than expected across nearly every academic department (Tables S5 and S6). This finding held true with respect to the appointment of women to department chair (Table S7).

UNADJUSTED ANALYSES

Kaplan–Meier curves for time to promotion according to sex suggest that women were appointed as assistant professor earlier and more often than men (Fig. S2). Among all women in the graduating cohorts, 22% were appointed as assistant professor, and among all men, 20% were appointed. However, men were promoted more often and more quickly to associate professor (Fig. 2A) — among all female assistant professors, 22% were promoted to associate professor, and among all men, 31% were promoted. This finding also held true for promotion to full professor (Fig. 2B); among all the female associate professors, 29% were promoted to full professor, and among all male associate professors, 40% were promoted to full professor. Men also were appointed more often and more quickly to department chair (Fig. S3). Among all female associate professors and full professors, 2% were appointed to department chair, and among all male associate professors and full professors, 6% were appointed department chair.

The Kaplan–Meier curves according to sex never converged or crossed — the percentages of women never reached or exceeded the percentages of men who were promoted. When the cohorts were split between early cohorts (1979–1997) and late cohorts (1998–2013), the event curves for promotion to associate professor and full professor (Figs. S4 and S5) and appointment to department chair (Fig. S6) were higher among men than among women for both sets of cohorts.

ADJUSTED COX PROPORTIONAL-HAZARDS MODELS

In adjusted Cox proportional-hazards models that included all the graduation cohorts (Table

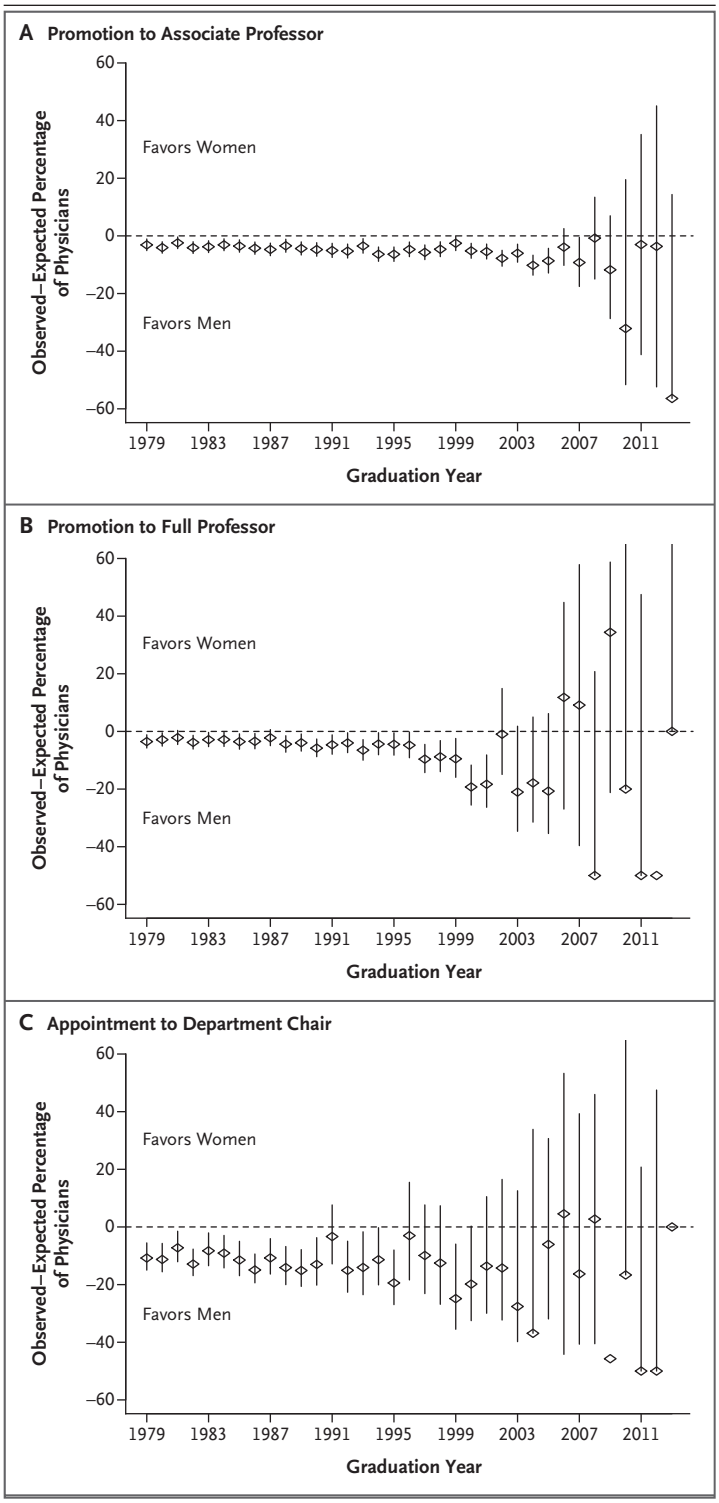

Figure 1. Promotion to Associate Professor or Full Professor or Appointment to Department Chair at U.S. Medical Schools, According to Sex and Graduation Year.

Shown are the percentages of graduates of U.S. medical schools who were promoted minus the percentages of those who would be expected to be promoted on the basis of the proportion of students in the graduating class. Panel A shows assistant professors who were promoted to associate professors, Panel B shows associate professors who were promoted to full professors, and Panel C shows associate or full professors who were appointed to department chair. Vertical lines indicate 95% confidence intervals. No confidence intervals are shown for cohorts in which no women were promoted to full professor (Panel B) or appointed to department chair (Panel C).

S8), the percentage of graduates who were appointed to assistant professor was 12% higher among women than men (hazard ratio, 1.12; 95% CI, 1.11 to 1.14). Across all the cohorts, women were 24% less likely than men to be promoted from assistant to associate professor (hazard ratio, 0.76; 95% CI, 0.74 to 0.78). Similarly, across all the cohorts, women were 23% less likely than men to be promoted from associate to full professor (hazard ratio, 0.77; 95% CI, 0.74 to 0.81).

In the model of promotion to associate professor that included an interaction term between sex and early or late cohort (Table 1), the disparity between women and men with respect to promotion in the later cohort (hazard ratio, 0.76; 95% CI, 0.72 to 0.79) was not significantly different from that in the early cohort (hazard ratio, 0.75; 95% CI, 0.73 to 0.78); the hazard ratio for the interaction was 1.0 (95% CI, 0.95 to 1.05). In the model of promotion to full professor that included the interaction between sex and cohort (Table 2), the disparity between women and men with respect to promotion was larger in the later cohort (hazard ratio, 0.62; 95% CI, 0.52 to 0.74) than in the earlier cohort (hazard ratio, 0.79; 95% CI, 0.76 to 0.83); the hazard ratio for the interaction was 0.78 (95% CI, 0.65 to 0.93).

Across all the cohorts, women were 54% less likely than men to be appointed to department chair (hazard ratio, 0.46; 95% CI, 0.39 to 0.54) (Table S10). In the model that included an interaction term between sex and cohort (Table 3), the disparity between women and men with respect to promotion in the later cohort (hazard ratio, 0.26; 95% CI, 0.13 to 0.53) was not significantly different from that in the earlier co-

hort (hazard ratio, 0.47; 95% CI, 0.40 to 0.56); the hazard ratio for the interaction was 0.55 (95% CI, 0.27 to 1.14).

Sensitivity analyses examined the effects of requiring 3.5 years and 7.0 years in rank (Tables S8 and S10) and censoring assumptions (Table S11 through S14) on promotion. The results of these analyses did not vary significantly from the main findings.

DISCUSSION

In an era in which women have closed the sex gap with respect to medical school admission,[6] women remain underrepresented in upper faculty ranks. The results of our study were consistent across 35 years of graduating classes. Adjustment for race or ethnic group, year of graduation, and type of department did not eliminate sex differences in promotion. Women associate and full professors were half as likely as men of equal rank to be appointed to department chair. Differences in promotion persisted across every academic department.

Our analyses comparing more recent and earlier cohorts suggest that women have lost ground in terms of promotion. This finding confirms those from other recent studies. Study results that were published in 2018 showed that over 17 years, among 1273 faculty members at 24 U.S. medical schools, women were less likely than men to attain leadership positions such as dean, associate dean, provost, and department chair, even after adjustment for publication-related productivity.[7] Women were found to be less likely than men to be full professors in a cross-sectional analysis involving faculty members in cardiology departments at U.S. medical schools. That analysis accounted for years since each faculty member was a resident, the cardiology subspecialty, the number of articles publishes, the receipt of National Institutes of Health grants, and participation in registered clinical trials.[8]

Our findings and those of previous studies indicate that academic medicine appears to be falling behind science, technology, engineering, and mathematics (STEM) in eliminating sex differences in promotion.[9] Among 2966 assistant professors in science and engineering who were tracked over time at 14 U.S. universities, the percentages of men and women who were retained and promoted were the same in all departments except for mathematics.[10]

The numerous potential causes of the sex gap in promotion include a persisting "old boys'

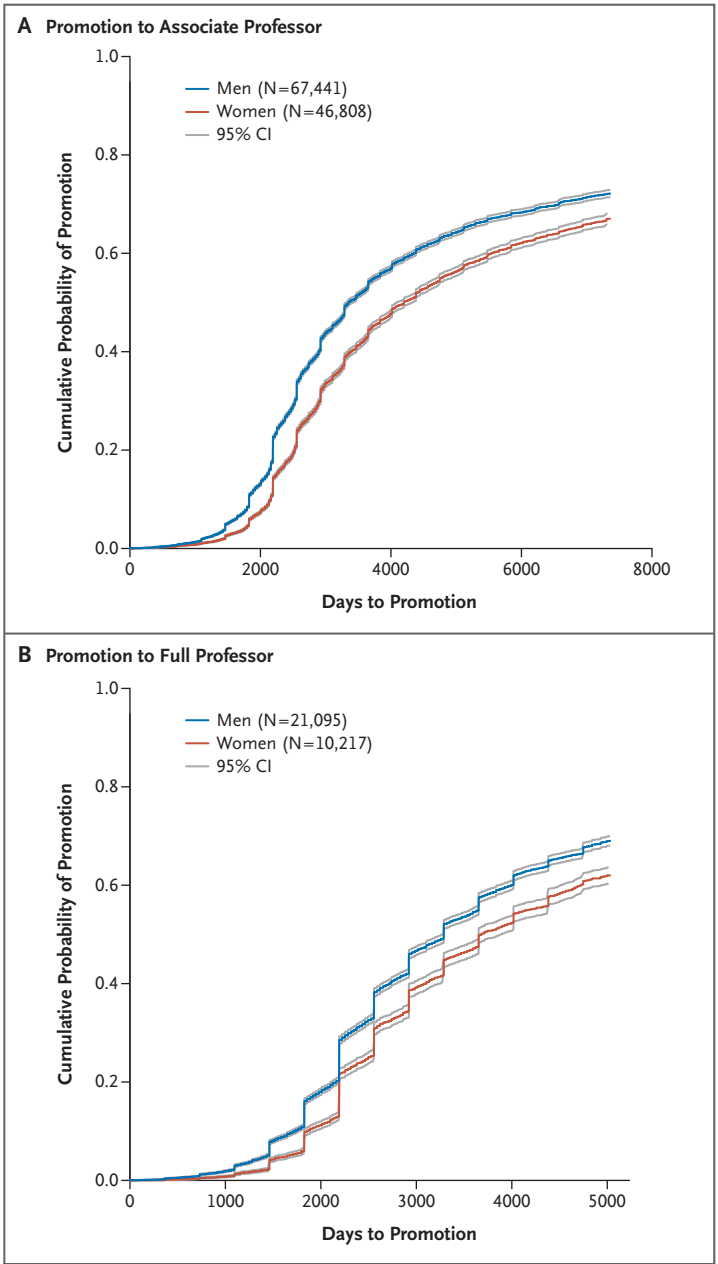

Figure 2. Time to Promotion to Upper Faculty Ranks, According to Sex.

Shown are Kaplan–Meier curves for time to promotion from assistant professor to associate professor (Panel A) and for time to promotion from associate professor to full professor (Panel B). Day 0 was the day on which a faculty member was promoted. The days to promotion are the number of days that it took for a faculty member to achieve promotion to the next rank.

Table 1. Promotion of 114,249 Assistant Professors to Rank of Associate Professor from 1979 through 2013, According to Sex and Early or Late Cohort.*

Variable	Assistant Professors at Day 0	Assistant Professors Promoted†	Assistant Professors with Censored Data‡	Hazard Ratio (95% CI)
	no./total no. (%)	*no.*	*no.*	
Sex				
Graduation 1998–2013				
Women	25,850/54,128 (47.8)	3,323	22,527	0.76 (0.72–0.79)
Men	28,278/54,128 (52.2)	5,235	23,043	Reference
Graduation 1979–1997				
Women	20,958/60,121 (34.9)	6,813	14,145	0.75 (0.73–0.78)
Men	39,163/60,121 (65.1)	15,726	23,437	Reference
Yr of graduation				
Women				
1998–2013	25,850/46,808 (55.2)	3,323	22,527	0.94 (0.90–0.98)
1979–1997	20,958/46,808 (44.8)	6,813	14,145	Reference
Men				
1998–2013	28,278/67,441 (41.9)	5,235	23,043	0.94 (0.91–0.97)
1979–1997	39,163/67,441 (58.1)	15,726	23,437	Reference
Race or ethnic group§				
American Indian or other Indigenous person¶	388/114,249 (0.3)	99	289	0.90 (0.74–1.17)
Asian	16,308/114,249 (14.3)	3,909	12,399	1.08 (1.04–1.11)
Black	6011/114,249 (5.3)	1,016	4,995	0.58 (0.54–0.61)
Hispanic or Latino‖	5678/114,249 (5.0)	1,085	4,593	0.74 (0.70–0.79)
Other**	1371/114,249 (1.2)	124	1,247	0.75 (0.63–0.89)
White	84,493/114,249 (74.0)	24,864	59,629	Reference
Department type				
Basic science	1614/114,249 (1.4)	441	1,173	1.18 (1.07–1.29)
Clinical or other	112,635/114,249 (98.6)	30,656	81,979	Reference

* A Cox proportional-hazards model was used, with an interaction term between sex and early or late cohort. Data were censored according to three criteria. First, because unequal follow-up between the original and later cohorts could potentially bias findings, we imposed a censoring criterion that was based on the maximum observed time to event (promotion or censoring) for a graduate of the later class cohorts (1998–2013); this maximum observed time to event was 7358 days. Second, to account for attrition from academic medicine, we censored data on physicians at the point when a gap of 3 years or more between faculty appointments occurred. Third, data on all faculty members who had not been promoted during the observation period (ending July 31, 2018) were right-censored. Day 0 was the day on which a faculty member was promoted.

† The median number of days to promotion was 2556 among women and 2342 among men.

‡ The median number of days before data were censored was 1499 among women and 1583 among men.

§ Race or ethnic group was reported by the graduates.

¶ This category includes American Indian, Alaska Native, Native Hawaiian, and Pacific Islander.

‖ This category includes Hispanic, Latino, person of Spanish origin, and multiracial Hispanic.

** This category includes other race or ethnic group, multiracial non-Hispanic, and unknown.

club" mentality and climate, lack of sex parity in leadership and compensation, lack of retention of women, a disproportionate burden of family responsibilities, and difficulties in achieving work–life balance.[11] A nationally representative survey conducted at U.S. medical colleges showed

Table 2. Promotion of 31,312 Associate Professors to Full Professor from 1979 through 2013, According to Sex and Early or Late Cohort.*

Variable	Associate Professors at Day 0	Associate Professors Promoted†	Associate Professors with Censored Data‡	Hazard Ratio (95% CI)
	no./total no. (%)	*no.*	*no.*	
Sex				
Graduation 1998–2013				
Women	3323/8558 (38.8)	165	3,158	0.62 (0.52–0.74)
Men	5235/8558 (61.2)	472	4,763	Reference
Graduation 1979–1997				
Women	6894/22,754 (30.3)	2,624	4,270	0.79 (0.76–0.83)
Men	15,860/22,754 (69.7)	7,506	8,354	Reference
Yr of graduation				
Women				
1998–2013	3323/10,217 (32.5)	165	3,158	0.73 (0.62–0.86)
1979–1997	6894/10,217 (67.5)	2,624	4,270	Reference
Men				
1998–2013	5235/21,095 (24.8)	472	4,763	0.94 (0.86–1.03)
1979–1997	15,860/21,095 (75.2)	7,506	8,354	Reference
Race or ethnic group§				
American Indian or other Indigenous person¶	99/31,312 (0.3)	19	80	0.92 (0.58–1.44)
Asian	3914/31,312 (12.5)	1,051	2,863	1.14 (1.07–1.21)
Black	1032/31,312 (3.3)	251	781	0.74 (0.66–0.84)
Hispanic or Latino‖	1090/31,312 (3.5)	316	774	0.93 (0.83–1.04)
Other**	125/31,312 (0.4)	33	92	0.97 (0.69–1.36)
White	25,052/31,312 (80.0)	9,097	15,955	Reference
Department type				
Basic science	442/31,312 (1.4)	184	258	1.37 (1.18–1.59)
Clinical or other	30,870/31,312 (98.6)	10,583	20,287	Reference

* A Cox proportional-hazards model was used, with an interaction term between sex and early or late cohort. Data were censored according to three criteria. First, because unequal follow-up between the original and later cohorts could potentially bias findings, we imposed a censoring criterion that was based on the maximum observed time to event (promotion or censoring) for a graduate of the later class cohorts (1998–2013); this maximum observed time to event was 5029 days. Second, to account for attrition from academic medicine, we censored data on physicians at the point when a gap of 3 years or more between faculty appointments occurred. Third, data on all faculty members who had not been promoted during the observation period (ending July 31, 2018) were right-censored. Day 0 was the day on which a faculty member was promoted.

† The median number of days to promotion was 2373 among women and 2192 among men.

‡ The median number of days before data were censored was 1594 among women and 1817 among men.

§ Race or ethnic group was reported by the graduates.

¶ This category includes American Indian, Alaska Native, Native Hawaiian, and Pacific Islander.

‖ This category includes Hispanic, Latino, person of Spanish origin, and multiracial Hispanic.

** This category includes other race or ethnic group, multiracial non-Hispanic, and unknown.

that female and male faculty members had similar leadership aspirations, but women were less likely to have a sense of belonging and to perceive their institution as family friendly or willing to make changes to address diversity goals.[12]

The lack of women at higher ranks, especially

Table 3. Appointment of 31,312 Associate or Full Professors to Department Chair from 1979 through 2013, According to Sex and Early or Late Cohort.*

Variable	Associate or Full Professors at Day 0	Associate or Full Professors Promoted†	Associate or Full Professors with Censored Data‡	Hazard Ratio (95% CI)
	no./total no. (%)	*no.*	*no.*	
Sex				
Graduation 1998–2013				
Women	3323/8558 (38.8)	9	3,314	0.26 (0.13–0.53)
Men	5235/8558 (61.2)	56	5,179	Reference
Graduation 1979–1997				
Women	6894/22,754 (30.3)	182	6,712	0.47 (0.40–0.56)
Men	15,860/22,754 (69.7)	871	14,989	Reference
Yr of graduation				
Women				
1998–2013	3323/10,217 (32.5)	9	3,314	0.45 (0.23–0.88)
1979–1997	6894/10,217 (67.5)	182	6,712	Reference
Men				
1998–2013	5235/21,095 (24.8)	56	5,179	0.81 (0.61–1.08)
1979–1997	15,860/21,095 (75.2)	871	14,989	Reference
Race or ethnic group§				
American Indian or other Indigenous person¶	99/31,312 (0.3)	1	98	0.47 (0.07–3.32)
Asian	3914/31,312 (12.5)	78	3,836	0.86 (0.68–1.08)
Black	1032/31,312 (3.3)	59	973	1.87 (1.43–2.43)
Hispanic or Latino‖	1090/31,312 (3.5)	32	1,058	0.96 (0.67–1.36)
Other**	125/31,312 (0.4)	8	117	2.07 (1.03–4.16)
White	25,052/31,312 (80.0)	940	24,112	Reference
Department type				
Basic science	442/31,312 (1.4)	21	421	1.42 (0.92–2.19)
Clinical or other	30,870/31,312 (98.6)	1097	29,773	Reference

* A Cox proportional-hazards model was used, with an interaction term between sex and early or late cohort. Data were censored according to 3 criteria. First, because unequal follow-up between the original and later cohorts could potentially bias findings, we imposed a censoring criterion that was based on the maximum observed time to event (promotion or censoring) for a graduate of the later class cohorts (1998–2013); this maximum observed time to event was 5029 days. Second, to account for attrition from academic medicine, we censored data on physicians at the point when a gap of 3 years or more between faculty appointments occurred. Third, data on all faculty members who had not been promoted during the observation period (ending July 31, 2018) were right-censored. Day 0 was the day on which a faculty member was promoted.

† The median number of days to promotion was 2707 among women and 2467 among men.

‡ The median number of days before data were censored was 1879 among women and 2124 among men.

§ Race or ethnic group was reported by the graduates.

¶ This category includes American Indian, Alaska Native, Native Hawaiian, and Pacific Islander.

‖ This category includes Hispanic, Latino, person of Spanish origin, and multiracial Hispanic.

** This category includes other race or ethnic group, multiracial non-Hispanic, and unknown.

in department chair positions, may perpetuate the cycle. Women are underrepresented both among residency program directors, who are role models and sponsors for career advancement,[13] and on editorial boards of medical journals, which prioritize areas of research and determine which

authors will have their work published.[14] We found that women physician graduates were more racially diverse than men, and our models showed that Indigenous persons, Blacks, and other persons of color were less likely than Whites to be promoted (Tables 1 through 3). Women in underrepresented minorities may pay a double price. Future studies should examine the effect of the intersection of race, ethnic group, and sex on promotion.

Lower earnings than those of men, harassment, or disproportionate family responsibilities could cause women to leave the field of medicine[15] or forgo advancement. Nearly one in three women physicians and clinician-researchers indicate that they have experienced sexual harassment in the workplace,[16,17] and this harassment appears to be more common in academic medical centers than in community or outpatient medical settings.[18] Most women physicians have children,[19] and most physicians who are mothers report they have been discriminated against because they were pregnant, took maternity leave, or were breast-feeding.[16]

A major limitation of this study is that we did not adjust for productivity or faculty track. We also excluded physicians who left and then returned to academic medicine. The strengths of the study include its large sample size, the linking of data regarding graduating cohort with faculty position, and the use of Kaplan–Meier curves and adjusted hazards regression. The racial and ethnic diversity of women graduates could have accounted for differences in promotion.[20] However, adjustment for race and ethnic group did not eliminate these differences.

Among medical students who graduated between 1979 and 2013, women who went into academic medicine were less likely than men to advance into upper faculty ranks. These gaps did not narrow during the 35-year time frame of this study.

Supported by the University of Kansas Medical Center Joy McCann Professorship for Women in Medicine (to Dr. Richter) and an international fellowship from the American Association of University Women (to Dr. Cruvinel).

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

We thank Lynn Nonnemaker, Ph.D., for responding to questions regarding her original analyses; Jiawei Duan, Ph.D., for assistance in formatting the figures; Andrew Roberts, Ph.D., for recommendations regarding analyses for the figures; and Amanda Grodie, M.P.H., for early assistance with study planning and logistics.

REFERENCES

1. Nonnemaker L. Women physicians in academic medicine: new insights from cohort studies. N Engl J Med 2000;342:399-405.
2. Jena AB, Khullar D, Ho O, Olenski AR, Blumenthal DM. Sex differences in academic rank in US medical schools in 2014. JAMA 2015;314:1149-58.
3. The state of women in academic medicine: the pipeline and pathways to leadership. Washington, DC: Association of American Medical Colleges, 2014.
4. Bunton SA, Sloane RA. The redistribution of tenure tracks for U.S. medical school faculty: clinical MD faculty (part I). Washington, DC: Association of American Medical Colleges, May 2015 (https://www.aamc.org/download/432328/data/may2015redistributionofrenureracksusmedicalschoolfacultypart1.pdf).
5. SI: SAS 9.4. Carey, NC: SAS Institute, 2013.
6. 2019 Fall applicant, matriculant, and enrollment data tables. Washington, DC: Association of American Medical Colleges, 2020.
7. Carr PL, Raj A, Kaplan SE, Terrin N, Breeze JL, Freund KM. Gender differences in academic medicine: retention, rank, and leadership comparisons from the national faculty survey. Acad Med 2018;93:1694-9.
8. Blumenthal DM, Olenski AR, Yeh RW, et al. Sex differences in faculty rank among academic cardiologists in the United States. Circulation 2017;135:506-17.
9. Williams WM, Ceci SJ. National hiring experiments reveal 2:1 faculty preference for women on STEM tenure track. Proc Natl Acad Sci U S A 2015;112:5360-5.
10. Kaminski D, Geisler C. Survival analysis of faculty retention in science and engineering by gender. Science 2012;335:864-6.
11. Carr PL, Gunn CM, Kaplan SA, Raj A, Freund KM. Inadequate progress for women in academic medicine: findings from the National Faculty Study. J Womens Health (Larchmt) 2015;24:190-9.
12. Pololi LH, Civian JT, Brennan RT, Dottolo AL, Krupat E. Experiencing the culture of academic medicine: gender matters, a national study. J Gen Intern Med 2013;28:201-7.
13. Long TR, Elliott BA, Warner ME, Brown MJ, Rose SH. Resident and program director gender distribution by specialty. J Womens Health (Larchmt) 2011;20:1867-70.
14. Amrein K, Langmann A, Fahrleitner-Pammer A, Pieber TR, Zollner-Schwetz I. Women underrepresented on editorial boards of 60 major medical journals. Gend Med 2011;8:378-87.
15. Jena AB, Olenski AR, Blumenthal DM. Sex differences in physician salary in US public medical schools. JAMA Intern Med 2016;176:1294-304.
16. Adesoye T, Mangurian C, Choo EK, Girgis C, Sabry-Elnaggar H, Linos E. Perceived discrimination experienced by physician mothers and desired workplace changes: a cross-sectional survey. JAMA Intern Med 2017;177:1033-6.
17. Jagsi R, Griffith KA, Jones R, Perumalswami CR, Ubel P, Stewart A. Sexual harassment and discrimination experiences of academic medical faculty. JAMA 2016;315:2120-1.
18. Nora LM, McLaughlin MA, Fosson SE, et al. Gender discrimination and sexual harassment in medical education: perspectives gained by a 14-school study. Acad Med 2002;77:1226-34.
19. Jolly S, Griffith KA, DeCastro R, Stewart A, Ubel P, Jagsi R. Gender differences in time spent on parenting and domestic responsibilities by high-achieving young physician-researchers. Ann Intern Med 2014;160:344-53.
20. Kaplan SE, Raj A, Carr PL, Terrin N, Breeze JL, Freund KM. Race/ethnicity and success in academic medicine: findings from a longitudinal multi-institutional study. Acad Med 2018;93:616-22.