Do Research Activities During College, Medical School, and Residency Mediate Racial/Ethnic Disparities in Full-Time Faculty Appointments at U.S. Medical Schools?

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Abstract

Purpose
To determine whether postsecondary research experiences (in college, medical school, and residency) and other variables mediate racial/ethnic disparities in U.S. medical school graduates' full-time faculty appointments in academic medicine.

Method
Individualized, deidentified records for 1994–2000 U.S. medical school matriculants who graduated with MDs before 2005, completed graduate medical education before 2009, and had data for all variables were examined for potential mediators of racial/ethnic disparities in full-time faculty appointments using the SAS macro "MEDIATE" for estimation and statistical inference. Controlling for gender, parents' occupation, and graduation year, the authors estimated the effects of potential mediators in separate models comparing Asian/Pacific Islander (PI) versus underrepresented minority (URM; including African American, Hispanic, and Native American/Alaska Native) graduates and white versus URM graduates.

Results
Of 82,758 eligible graduates, 62,749 (75.8%) had complete data; of these, 11,234 (17.9%) had full-time faculty appointments, including 18.4% (7,848/42,733) of white, 18.8% (2,125/11,297) of Asian/PI, and 14.5% (1,261/8,719) of URM graduates. Proportion of total race/ethnicity effect on full-time faculty appointment explained by all mediators was 66.0% (95% confidence interval [CI], 44.7%–87.4%) in a model comparing Asians/PIs with URMs and 64.8% (95% CI, 52.2%–77.4%) in one comparing whites with URMs. Participation in postsecondary research activities, authorship during medical school, academic achievement, and faculty career intentions at graduation were among the significant mediators explaining the effect of race/ethnicity on full-time faculty appointment.

Conclusions
Postsecondary research experiences for URM students are among the mediators of racial/ethnic disparities in full-time faculty appointments and, therefore, may increase academic medicine faculty diversity.

A diverse workforce is essential to academic medicine's mission of excellence in teaching, patient care, and research.[1] However, the academic medicine workforce in the United States remains lacking in racial and ethnic diversity. Historically underrepresented minorities (URMs)—which we defined in this study as including non-Hispanic African Americans, Hispanics (any race), and Native Americans/Alaska Natives—constituted about 29% of the total U.S. population in 2010[2] but made up only 7.0% (9,635/137,925) of all full-time faculty at U.S. Liaison Committee on Medical Education (LCME)–accredited medical schools in 2011.[3]

Medical graduates holding MD degrees (with or without other advanced degrees) constituted 71.4% of the U.S. medical school faculty in 2010[4] and 71.7% in 2011.[3] Therefore, faculty racial/ethnic diversity reflects, at least in part, the diversity of U.S. medical school graduates. URMs accounted for 14.6% (2,247/15,338) of U.S. medical graduates in 2008,[5] whereas in 2011, only 8.3% (8,256/98,904) of U.S. medical school faculty holding MD degrees were URMs.[3] Thus, the representation of URM medical graduates in academic medicine faculty remains well below even their relatively low representation among U.S. medical school graduates.

We conducted a retrospective, national cohort study in 2011 to test two hypotheses related to racial/ethnic disparities in academic medicine faculty appointments in the United States. First, we hypothesized that among U.S. medical graduates, the proportion of URM graduates appointed to full-time faculty positions would be lower than the proportion of non-URM graduates appointed to such positions. Second, as participation in research is among the variables reportedly associated with choosing academic medicine as a career,[6,7] racial/ethnic disparities in research participation may contribute to disparities in the academic medicine workforce.[8,9] Thus, we also hypothesized that participation in formal research experiences during college, medical school, and graduate medical education (GME) would mediate the association between race/ethnicity and full-time

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academic medicine faculty appointment among U.S. medical school graduates.

Method

The database for this study included individualized, deidentified records for all 1994–2000 matriculants at LCME-accredited medical schools in the United States (including Hawaii and Puerto Rico) who graduated before 2005 and had completed GME as of 2009. The institutional review board at Washington University School of Medicine deemed this study to be non–human subjects research.

Measures

On the basis of the literature regarding factors associated with medical graduates' pursuit of careers in academic medicine[6,7] and factors that may specifically contribute to the racial/ethnic disparities in the academic medicine workforce,[8–12] we identified a set of demographic, research-related, and educational/professional development variables that might affect the association between race/ethnicity and full-time academic medicine faculty appointment.

With permission from the Association of American Medical Colleges (AAMC), the National Board of Medical Examiners (NBME), and the American Medical Association (AMA), the AAMC provided us with graduates' most recent Medical College Admission Test (MCAT) scores as well as data from the AAMC's Student Records System (SRS), Data Warehouse, Matriculating Student Questionnaire (MSQ), Graduation Questionnaire (GQ), GME Track, and Faculty Roster. The AAMC also provided us with data from the NBME and from the AMA Physician Masterfile, which were released to the AAMC on our behalf by the NBME and by Medical Marketing Services (MMS), Inc., a licensed AMA Masterfile vendor, respectively. We entered into data use agreements with the AAMC, NBME, and MMS, Inc. Unique, AAMC-generated identification numbers were used to merge individual students' deidentified data for analysis.

We computed a composite score for each graduate's most recent MCAT as the sum of his or her Verbal Reasoning, Biological Sciences, and Physical Sciences subscores. SRS variables included gender (female versus male), race/ethnicity (self-identified on the American Medical College Application Service [AMCAS] questionnaire), graduation year, and degree program at graduation. We categorized race/ethnicity as Asian/Pacific Islander (PI; including Japanese, Filipino, Vietnamese, Korean, Chinese, Indian, Pakistani, other Asian, Hawaiian, and other Pacific Islander), URM, white, and other/unknown if they could not be categorized because they self-identified as "other" or multiple races or they did not indicate any race/ethnicity on the AMCAS questionnaire. Graduation-year data (1998–2004) were updated through July 2011. As MD degree program graduates typically complete a program of specialty GME prior to entering the physician workforce, we included individuals who graduated before 2005 to allow for at least a five-year period after graduation at the time of first faculty appointment. Finally, we included only MD graduates in our analysis because there are inherent differences in the duration and scope of the program curricula for combined advanced-degree programs (i.e., MD/PhD, MD/other advanced degree).[13,14]

We included four items from the MSQ and five items from the GQ, which are administered annually to incoming and graduating medical students, respectively, on a confidential and voluntary basis.[15,16] As a proxy for socioeconomic status, we used two MSQ items pertaining to mother's and father's occupations to create a four-category parent occupation variable (unknown [no response], one/both a physician, one/both a professional but not a physician, neither parent a physician or a professional). We also included MSQ items for participation in a college laboratory research apprenticeship (yes versus no) and for career-setting preference, which we used to create a variable for full-time faculty career intention at matriculation (yes versus no).

For the GQ item "Indicate the activities you will have participated in during medical school on an elective or volunteer (not required) basis," we included responses for "Research project with faculty member" (yes versus no) and "Authorship (sole or joint) of a research paper submitted for publication" (yes versus no). We created a five-category variable for total debt at graduation (no debt, $1–$49,999, $50,000–$99,999, $100,000–$149,999, ≥$150,000). We also created a dichotomous variable for career intention at graduation (full-time faculty versus all other career intentions) and a five-category variable for specialty choice at graduation (family medicine, surgery/surgery specialties, no specialty choice made, all other specialties, internal medicine/pediatrics/combined internal medicine and pediatrics [IM/Peds/IM&Peds]).

With permission from the NBME, the AAMC provided graduates' three-digit, first-attempt scores on the United States Medical Licensing Examination (USMLE) Step l, which assesses the examinee's knowledge of basic sciences relevant to medical practice.[17] In addition, the AAMC provided an indicator for attendance at a research-intensive medical school (i.e., ranked among the top 40 for National Institutes of Health [NIH] funding).[18]

Using the AAMC GME Track data from the national GME Census,[19,20] we created a dichotomous variable to distinguish between graduates who were and were not reported by program directors to have completed at least one year of research during GME.

We used type of practice setting and year of training variables in the AMA Physician Masterfile for our inclusion criteria, excluding graduates listed as still in training in 2009. The AAMC Faculty Roster definition of full-time faculty members does not include residents and fellows[21]; thus, graduates still in GME would not be eligible for full-time faculty appointments. The Faculty Roster includes data submitted from U.S. LCME-accredited medical schools and is maintained with NIH support.[22] We created a dichotomous variable for our outcome, full-time faculty appointment (yes versus no), to distinguish between graduates who had held any full-time faculty appointments (active and inactive) at U.S. medical schools through July 2009—the end date of the Faculty Roster data—and those who had not. We excluded graduates who had held other types of faculty appointment (i.e., part-time or voluntary).

Statistical analysis

We used chi-square tests to describe associations among categorical variables and analysis of variance to describe

between-groups differences in continuous variables. We report descriptive statistics for each variable included in our models, grouped by race/ethnicity and by full-time faculty appointment. We computed tetrachoric correlations between binary variables, biserial correlations between binary and continuous variables, and Spearman correlations between continuous variables. We ran three multivariate logistic regression models stratified by race/ethnicity to identify independent predictors of full-time faculty appointment; we report adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for all predictor variables in these models.

We examined the potential mediating effects of each of 11 variables on the relationship between race/ethnicity and full-time faculty appointment in two separate models: one comparing Asian/PI and URM graduates and the other comparing white and URM graduates. These potential mediating variables were (1) college research apprenticeship, (2) MCAT score, (3) full-time faculty career intention at medical school matriculation, (4) elective research project with faculty member in medical school, (5) authorship on a paper during medical school, (6) attendance at a research-intensive medical school, (7) total debt at medical school graduation, (8) full-time faculty career intention at medical school graduation, (9) USMLE Step l score, (10) specialty choice at medical school graduation, and (11) research during GME. The outcome variable was full-time faculty appointment at a U.S. medical school accredited by the LCME. The mediation models included as confounders those variables that were not assumed in the pathway but were associated with race/ethnicity and/or with full-time faculty appointment. Figure 1 illustrates a simple path diagram of our mediation model, as described below.

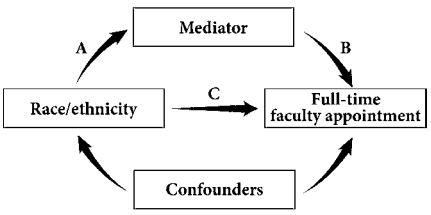

Figure 1 Path diagram of this study's mediation model of the association between race/ethnicity and full-time academic medicine faculty appointment, controlling for confounders.

Within the specified mediation framework, we followed the approaches suggested by Baron and Kenny[23] and Judd and Kenny[24] to empirically evaluate these possible mediating variables. First, we measured the effect of race/ethnicity on full-time faculty appointment after adjusting for the confounding variables using a binary logistic regression model (Path C). Then, we measured the effect of race/ethnicity on each of the potential mediating variables using appropriate regression models, with each of the mediating variables as the outcome and race/ethnicity as a predictor (Path A). Next, we measured the effect of each potential mediating variable on full-time faculty appointment using binary logistic regression models (Path B); in these models, we also included race/ethnicity as a covariate. Potential mediating variables that were found to be associated with race/ethnicity in the presumed direction (i.e., that URM students were less likely than white or than Asian/PI students to have a particular research experience) and that were significantly associated with faculty appointment in the preliminary regression models were selected for the mediation effect analysis.

The mediation effect was quantified by the proportion of treatment effect (PTE) explained by a mediator.[25] In our setting, the PTE is the proportion of race/ethnicity effect on full-time faculty appointment explained by a mediator. The PTE was obtained by first estimating regression coefficients of race/ethnicity on full-time faculty appointment with and without the mediator adjusting for the same set of confounders, then dividing the difference between the two regression coefficients by the regression coefficient from the model without the mediator. We used the public SAS macro MEDIATE[26] for estimation and statistical inference (the CI and test of significance) of the mediation effect for each of the mediators alone, for mediators that were correlated with each other in a block, and for all significant mediators together. Analyses were performed using SAS version 9.3 (SAS Institute, Inc., Cary, North Carolina). Two-sided $P < .05$ was considered significant.

Results

Of 113,522 individualized, deidentified records for all 1994–2000 matriculants at LCME-accredited U.S. medical schools, we excluded the 1,316 (1%) students whose race/ethnicity was "other" or unknown. Of the remaining 112,206 students, we excluded the 27,840 (25%) who graduated after 2004 and/or were still in GME as of 2009. From the remaining 84,366 graduates, we further excluded the 1,608 (2%) with MD/PhDs and MD/other advanced degrees. Thus, 82,758 U.S. medical school graduates in our database met our eligibility criteria: They matriculated between 1994 and 2000, graduated from 1998 through 2004 with MD degrees only, completed GME before 2009, and could be assigned to a race/ethnicity category.

Of these eligible graduates, our final study sample included the 62,749 (75.8%) who had complete data for all variables of interest. Among the graduates excluded because of missing data, there were higher proportions of URM and Asian/PI graduates than white graduates (26.8% and 26.2% versus 23.0%, respectively; $P < .001$), of men than women (24.5% versus 23.8%, respectively; $P = .029$), and of graduates without than with full-time faculty appointments (24.4% versus 23.3%, respectively; $P = .005$).

Table 1 shows the frequencies (%) of graduates for each of the potential confounders and mediators grouped by race/ethnicity and by full-time faculty appointment. As we hypothesized, the proportion of URM graduates who had held faculty appointments (14.5%) was lower than that of either Asian/PI graduates (18.8%) or white graduates (18.4%). Consistent with the presumed direction of associations, lower proportions of URM than Asian/PI graduates had participated in college research apprenticeships, medical school research electives, and research during GME. Contrary to the presumed direction of associations, higher proportions of URM than white graduates had participated in college research apprenticeships and medical school research electives; however, a lower proportion of URM than white graduates had participated in research during GME. Across all graduates, participation in research during GME varied by specialty choice at graduation, ranging from a low of 2.3% (171/7,478 graduates) for family medicine to highs of 15.5% (2,637/16,970 graduates)

Table 1

Distribution of Confounders and Potential Mediators by Race/Ethnicity and by the Outcome, Full-Time Faculty Appointment, Among 1998–2004 Graduates of U.S. Liaison Committee on Medical Education (LCME)–Accredited Medical Schools*

		Race/ethnicity			Full-time faculty appointment	
	Total N = 62,749	URM n = 8,719	Asian/PI n = 11,297	White n = 42,733	No n = 51,515	Yes n = 11,234
(% of total N)	—	(13.9)	(18.0)	(68.1)	(82.1)	(17.9)
Outcome: full-time faculty appointment,† no. (%)						
No	51,515 (82.1)	7,458 (85.5)	9,172 (81.2)	34,885 (81.6)	—	—
Yes	11,234 (17.9)	1,261 (14.5)	2,125 (18.8)	7,848 (18.4)	—	—
Confounders						
Gender,‡ no., (%)						
Female	28,795 (45.9)	4,886 (56.0)	5,240 (46.4)	18,669 (43.7)	23,322 (45.3)	5,473 (48.7)
Male	33,954 (54.1)	3,833 (44.0)	6,057 (53.6)	24,064 (56.3)	28,193 (54.7)	5,761 (51.3)
Parent occupation,§ no. (%)						
Unknown [no response]	3,257 (5.2)	647 (7.4)	645 (5.7)	1,965 (4.6)	2,769 (5.4)	488 (4.3)
One/both a physician	9,535 (15.2)	906 (10.4)	2,663 (23.6)	5,966 (14.0)	7,562 (14.7)	1,973 (17.6)
One/both a professional but not a physician	15,053 (24.0)	1,795 (20.6)	1,636 (14.5)	11,622 (27.2)	12,175 (23.6)	2,878 (25.6)
Neither parent a physician or a professional	34,904 (55.6)	5,371 (61.6)	6,353 (56.2)	23,180 (54.2)	29,009 (56.3)	5,895 (52.5)
Graduation year,‡ no. (%)						
1998	9,163 (14.6)	1,163 (13.3)	1,533 (13.6)	6,467 (15.1)	7,406 (14.4)	1,757 (15.6)
1999	10,121 (16.1)	1,412 (16.2)	1,899 (16.8)	6,810 (15.9)	8,016 (15.6)	2,105 (18.7)
2000	11,290 (18.0)	1,617 (18.5)	1,924 (17.0)	7,749 (18.1)	8,957 (17.4)	2,333 (20.8)
2001	10,942 (17.4)	1,488 (17.1)	2,084 (18.4)	7,370 (17.2)	8,855 (17.2)	2,087 (18.6)
2002	9,684 (15.4)	1,380 (15.8)	1,812 (16.0)	6,492 (15.2)	8,165 (15.8)	1,519 (13.5)
2003	7,470 (11.9)	1,067 (12.2)	1,386 (12.3)	5,017 (11.7)	6,431 (12.5)	1,039 (9.2)
2004	4,079 (6.5)	592 (6.8)	659 (5.8)	2,828 (6.6)	3,685 (7.2)	394 (3.5)
Potential mediators						
Faculty career intention at matriculation,§ no. (%)						
Yes	7,385 (11.8)	940 (10.8)	1,800 (15.9)	4,645 (10.9)	5,352 (10.4)	2,033 (18.1)
No	55,364 (88.2)	7,779 (89.2)	9,497 (84.1)	38,088 (89.1)	46,163 (89.6)	9,201 (81.9)
College research apprenticeship,§ no. (%)						
No	34,411 (54.8)	4,821 (55.3)	4,652 (41.2)	24,938 (58.4)	28,663 (55.6)	5,748 (51.2)
Yes	28,338 (45.2)	3,898 (44.7)	6,645 (58.8)	17,795 (41.6)	22,852 (44.4)	5,486 (48.8)
Medical school research elective,¶ no. (%)						
No	29,746 (47.4)	4,077 (46.8)	4,669 (41.3)	21,000 (49.1)	25,118 (48.8)	4,628 (41.2)
Yes	33,003 (52.6)	4,642 (53.2)	6,628 (58.7)	21,733 (50.9)	26,397 (51.2)	6,606 (58.8)
Authorship during medical school,¶ no. (%)						
No	42,053 (67.0)	6,236 (71.5)	7,091 (62.8)	28,726 (67.2)	35,188 (68.3)	6,865 (61.1)
Yes	20,696 (33.0)	2,483 (28.5)	4,206 (37.2)	14,007 (32.8)	16,327 (31.7)	4,369 (38.9)
Total debt at graduation,¶ no. (%)						
No debt	9,571 (15.3)	715 (8.2)	2,518 (22.3)	6,338 (14.8)	7,731 (15.0)	1,840 (16.4)
$1–$49,999	9,219 (14.7)	1,288 (14.8)	1,978 (17.5)	5,953 (13.9)	7,547 (14.7)	1,672 (14.9)
$50,000–$99,999	18,480 (29.5)	2,900 (33.3)	3,002 (26.6)	12,578 (29.4)	15,115 (29.3)	3,365 (30.0)
$100,000–$149,999	16,096 (25.7)	2,407 (27.6)	2,202 (19.5)	11,487 (26.9)	13,309 (25.8)	2,787 (24.8)
≥$150,000	9,383 (15.0)	1,409 (16.2)	1,597 (14.1)	6,377 (14.9)	7,813 (15.2)	1,570 (14.0)
Research-intensive medical school,** no. (%)						
No	41,906 (66.8)	6,102 (70.0)	7,083 (62.7)	28,721 (67.2)	35,166 (68.3)	6,740 (60.0)
Yes	20,843 (33.2)	2,617 (30.0)	4,214 (37.3)	14,012 (32.8)	16,349 (31.7)	4,494 (40.0)

(Table continues)

Table 1, continued

	Total N = 62,749	Race/ethnicity			Full-time faculty appointment	
		URM n = 8,719	Asian/PI n = 11,297	White n = 42,733	No n = 51,515	Yes n = 11,234
Faculty career intention at graduation,¶ no. (%)						
Yes	15,696 (25.0)	1,909 (21.9)	3,569 (31.6)	10,218 (23.9)	10,964 (21.3)	4,732 (42.1)
No	47,053 (75.0)	6,810 (78.1)	7,728 (68.4)	32,515 (76.1)	40,551 (78.7)	6,502 (57.9)
Specialty choice at graduation,¶ no. (%)						
IM/Peds/IM&Peds	16,970 (27.0)	2,310 (26.5)	3,475 (30.8)	11,185 (26.2)	13,037 (25.3)	3,933 (35.0)
Family medicine	7,478 (11.9)	1,093 (12.5)	762 (6.7)	5,623 (13.2)	7,004 (13.6)	474 (4.2)
Surgery/surgery specialties	7,848 (12.5)	933 (10.7)	1,265 (11.2)	5,650 (13.2)	6,532 (12.7)	1,316 (11.7)
No specialty selected	5,921 (9.4)	830 (9.5)	1,407 (12.5)	3,684 (8.6)	4,998 (9.7)	923 (8.2)
All other specialties	24,532 (39.1)	3,553 (40.8)	4,388 (38.8)	16,591 (38.8)	19,944 (38.7)	4,588 (40.8)
Research in GME,†† no. (%)						
No	57,117 (91.0)	8,052 (92.4)	10,085 (89.3)	38,980 (91.2)	47,627 (92.5)	9,490 (84.5)
Yes	5,632 (9.0)	667 (7.6)	1,212 (10.7)	3,753 (8.8)	3,888 (7.5)	1,744 (15.5)
MCAT score,‡‡ mean (SD)	29.2 (4.3)	24.4 (4.8)	30.6 (3.8)	29.9 (3.7)	29.1 (4.3)	30.0 (4.2)
USMLE Step 1 score,§§ mean (SD)	215.5 (20.8)	199.9 (21.9)	216.0 (19.8)	218.6 (19.4)	214.6 (20.9)	219.7 (20.0)

*For all comparisons, $P < .001$ because of large sample size. The database included graduates of all U.S. LCME-accredited medical schools including those in Hawaii and Puerto Rico; the sample included graduates who completed graduate medical education (GME) before 2009. URM, indicates underrepresented minority; PI, Pacific Islander; IM, internal medicine; Peds, pediatrics; MCAT, Medical College Admission Test; USMLE, United States Medical Licensing Examination.
†Source: Association of American Medical Colleges (AAMC) Faculty Roster.
‡Source: AAMC Student Record System.
§Source: AAMC Matriculating Student Questionnaire.
¶Source: AAMC Graduation Questionnaire.
**Source: AAMC; yes/no determined using an indicator variable based on the top 40 medical schools funded by the National Institutes of Health.[18]
††Source: AAMC and American Medical Association national GME Census (GME Track).
‡‡Source: AAMC Data Warehouse. Score is for the most recent attempt.
§§Source: AAMC, with permission of the National Board of Medical Examiners. Score is for the first attempt.

and 16.4% (1,285/7,848 graduates) for IM/Peds/IM&Peds and for surgery/surgery specialties, respectively (data not shown). Gender, parent occupation, and graduation year were significantly associated with race/ethnicity and full-time faculty appointment and were included as confounders in the regression and mediation models because they are not amenable to intervention.

Tetrachoric correlations among the binary variables illustrate low-to-moderate correlations among most of these potential mediators, and only medical school research elective participation and authorship of a paper during medical school were highly correlated (0.799). We also examined biserial and rank biserial correlations between binary and continuous variables and Spearman correlations among the continuous variables considered as potential mediators, finding low correlations among these variables (see Supplemental Digital Tables 1, 2, and 3, http://links.lww.com/ACADMED/A107).

Table 2 shows the results of three multivariate logistic regression models stratified by race/ethnicity to identify independent predictors of full-time faculty appointment. In all models, graduates who were female, had higher USMLE Step l scores, had graduated from a research-intensive medical school, had reported faculty career intentions at matriculation and at graduation, and had participated in at least one year of research during GME were more likely—whereas graduates who had selected family medicine or surgery specialties and graduated more recently were less likely—to have held a faculty appointment. Participation in a college research apprenticeship was associated with faculty appointment only among URM graduates; authorship on a paper during medical school was associated with faculty appointment only among white graduates. Medical school research elective participation was not a significant predictor of faculty appointment in any model; however, in models that excluded authorship (not shown), medical school research elective was positively associated with faculty appointment.

Table 3 shows the effects of race/ethnicity on each of the categorical potential mediators (Path A) and on full-time faculty appointment (Path C) in logistic regression models that controlled for gender, parent occupation, and graduation year. Table 4 shows the effects of potential mediators on faculty appointment for each of the two models: Asian/PI versus URM and white versus URM.

As shown in Table 3, both white (AOR 1.330) and Asian/PI (AOR 1.354) graduates were more likely than URM graduates to have held full-time faculty appointments. Asian/PI graduates also were more likely than URM graduates to have participated in each of the various research experiences, graduated from a research-intensive medical school, authored a paper during medical school, and reported full-time faculty career intentions at graduation, but they were less likely than URM graduates to have reported faculty career intentions at matriculation. Findings differed somewhat for the comparisons of white and URM graduates. For college research apprenticeship and medical

Table 2

Multivariate Logistic Regression Models of Predictors of Full-Time Faculty Appointment Among Each of the Confounders and Potential Mediators, Stratified by Race/Ethnicity for 1998–2004 Graduates of U.S. Liaison Committee on Medical Education (LCME)–Accredited Medical Schools*

	Full-time faculty appointment, AOR (95% CI)		
Confounders and potential mediators	**URM n = 8,719**	**Asian/PI n = 11,297**	**White n = 42,733**
Confounders			
Gender			
Female	1.226 (1.077–1.397)	1.165 (1.052–1.290)	1.261 (1.195–1.329)
Male	1.000 (reference)	1.000 (reference)	1.000 (reference)
Parent occupation			
Unknown [no response]	0.872 (0.675–1.128)	0.902 (0.717–1.135)	0.931 (0.818–1.060)
One/both a physician	1.197 (0.985–1.455)	1.116 (0.985–1.264)	1.144 (1.061–1.235)
One/both a professional but not a physician	1.029 (0.881–1.202)	1.168 (1.016–1.344)	1.096 (1.033–1.163)
Neither parent a physician or a professional	1.000 (reference)	1.000 (reference)	1.000 (reference)
Graduation year†	0.881 (0.849-0.915)	0.866 (0.840-0.892)	0.908 (0.895–0.922)
Potential mediators			
MCAT score‡	1.030 (1.014–1.047)	0.997 (0.981–1.013)	1.012 (1.003–1.020)
USMLE Step1 score§	1.005 (1.001–1.008)	1.004 (1.001–1.007)	1.006 (1.005–1.008)
Total debt at graduation¶	0.988 (0.934–1.044)	0.951 (0.914–0.989)	1.016 (0.995–1.037)
Research-intensive medical school			
Yes	1.177 (1.023–1.354)	1.202 (1.078–1.340)	1.085 (1.025–1.148)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)
Faculty career intention at matriculation			
Yes	1.253 (1.046–1.500)	1.164 (1.024–1.322)	1.295 (1.201–1.396)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)
College research apprenticeship			
Yes	1.158 (1.021–1.312)	0.969 (0.876–1.072)	1.051 (0.998–1.107)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)
Medical school research elective			
Yes	1.066 (0.923–1.232)	0.966 (0.856–1.091)	1.047 (0.984–1.115)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)
Authorship during medical school			
Yes	1.128 (0.971–1.312)	1.041 (0.925–1.171)	1.090 (1.023–1.162)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)
Faculty career intention at graduation			
Yes	1.802 (1.567–2.071)	2.129 (1.914–2.369)	2.023 (1.910–2.144)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)
Specialty choice at graduation			
Family medicine	0.463 (0.355–0.604)	0.367 (0.268–0.501)	0.311 (0.276–0.350)
Surgery/surgery specialties	0.651 (0.520–0.815)	0.830 (0.700–0.985)	0.561 (0.513–0.613)
No specialty selected	0.817 (0.641–1.042)	0.849 (0.712–1.013)	0.825 (0.746–0.911)
All other specialties	0.961 (0.829–1.113)	1.149 (1.021–1.294)	0.870 (0.817–0.925)
IM/Peds/IM&Peds	1.000 (reference)	1.000 (reference)	1.000 (reference)
Research in GME			
Yes	1.555 (1.274–1.898)	1.490 (1.290–1.721)	1.696 (1.567–1.835)
No	1.000 (reference)	1.000 (reference)	1.000 (reference)

*The database included graduates of all U.S. LCME-accredited medical schools including those in Hawaii and Puerto Rico; the sample included graduates who completed graduate medical education (GME) before 2009. All variables were included in each model. Hosmer–Lemeshow goodness-of-fit test (each model $P > .05$); 95% confidence intervals (CIs) that include the value 1.000 are not statistically significant. AOR indicates adjusted odds ratio; URM, underrepresented minority; PI, Pacific Islander; MCAT, Medical College Admission Test; USMLE, United States Medical Licensing Examination; IM, internal medicine; Peds, pediatrics.

† AOR < 1.000 indicates a lower likelihood of full-time faculty appointment for each increasing year of graduation.

‡ AOR > 1.000 indicates a higher likelihood of full-time faculty appointment for each one-point-unit increase in most-recent-attempt MCAT score.

§ AOR > 1.000 indicates a higher likelihood of full-time faculty appointment for each one-point-unit increase in first-attempt Step 1 score.

¶ AOR < 1.000 indicates a lower likelihood of full-time faculty appointment for each $50,000-unit increase in debt.

Table 3

Logistic Regression Models Testing the Effects of Race/Ethnicity on Each of the Potential Categorical Mediators (Path A) and on the Outcome (Path C) Among 1998–2004 Graduates of U.S. Liaison Committee on Medical Education (LCME)–Accredited Medical Schools (N = 62,749)*

Potential mediators and outcome	Effects of race/ethnicity on each potential mediator, AOR (95% CI)†	
	Model 1: Asian/PI versus URM, n = 20,016	Model 2: White versus URM, n = 51,452
Potential mediators		
Faculty career intention at matriculation		
No	1.000 (reference)	1.000 (reference)
Yes	1.536 (1.410–1.675)	0.962 (0.892–1.036)
College research apprenticeship		
No	1.000 (reference)	1.000 (reference)
Yes	1.829 (1.726–1.938)	0.886 (0.845–0.929)
Medical school research elective		
No	1.000 (reference)	1.000 (reference)
Yes	1.191 (1.124–1.261)	0.855 (0.816–0.896)
Authorship during medical school		
No	1.000 (reference)	1.000 (reference)
Yes	1.424 (1.339–1.515)	1.153 (1.095–1.214)
Research-intensive medical school		
No	1.000 (reference)	1.000 (reference)
Yes	1.407 (1.324–1.496)	1.141 (1.085–1.200)
Faculty career intention at graduation		
No	1.000 (reference)	1.000 (reference)
Yes	1.637 (1.533–1.749)	1.103 (1.043–1.166)
Specialty choice at graduation		
IM/Peds/IM&Peds	1.000 (reference)	1.000 (reference)
Family medicine	0.493 (0.442–0.549)	1.078 (0.996–1.167)
Surgery/surgery specialties	0.774 (0.698–0.858)	1.053 (0.968–1.147)
No specialty selected	1.167 (1.052–1.294)	0.949 (0.868–1.037)
All other specialties	0.790 (0.736–0.848)	0.934 (0.881–0.991)
Research during GME		
No	1.000 (reference)	1.000 (reference)
Yes	1.418 (1.281–1.569)	1.118 (1.025–1.219)
Outcome: Full-time faculty appointment		
No	1.000 (reference)	1.000 (reference)
Yes	1.354 (1.252–1.464)	1.330 (1.246–1.420)

*The database included graduates of all U.S. LCME-accredited medical schools including those in Hawaii and Puerto Rico; the sample included graduates who completed graduate medical education (GME) before 2009. AOR indicates adjusted odds ratio; CI, confidence interval; PI, Pacific Islander; URM, underrepresented minority; IM, internal medicine; Peds, pediatrics.

† Models are adjusted for gender, parent occupation, and graduation year; 95% CIs that include the value 1.000 are not statistically significant.

school research elective, the direction of the race/ethnicity effect was reversed, indicating that white graduates were less likely than URM graduates to have participated in each of these research opportunities. Although white graduates were more likely than URM graduates to have reported faculty career intentions at graduation, they were neither more nor less likely than URM graduates to have done so at matriculation. When each category of specialty choice at graduation was compared against IM/Peds/IM&Peds, Asian/PI graduates were less likely than URM graduates to have chosen family medicine, surgery/surgery specialties, and all other specialties, but were more likely not to have picked a specialty; white graduates were less likely than URM graduates to have chosen all other specialties. We also examined the effects of race/ethnicity on MCAT score, Step 1 score, and total debt at graduation (Path A) using linear regression; in these models, Asian/PI and white graduates received higher scores on average on the MCAT and the Step 1 examination and reported lower levels of debt compared with URM graduates (each $P < .0001$; also see Table 1).

The results in Table 4 show similar, although not identical, patterns of association between the potential mediators and full-time faculty appointment in both the comparisons of Asian/PI and URM graduates and of white and URM graduates. All potential mediators were associated with greater likelihood of faculty appointment in both models, with the exception of total debt and specialty choice at graduation (for the latter, see results for the other specialty categories).

Table 5 shows the PTE of race/ethnicity on faculty appointment explained by each mediating variable and by blocks of significant mediators in one model. Although there were many similarities between the two models—comparing Asian/PI with URM graduates and white with URM graduates—there were some notable differences. Although the lower participation of URM than Asian/PI graduates in college research apprenticeships and medical school research electives could explain the disparity in faculty appointment between URM and Asian/PI graduates, we did not evaluate the mediating effects of college research apprenticeships and medical school research electives in the white versus URM comparisons because white graduates were less likely than URM graduates to have reported participation in these activities. Debt was not a mediator in the Asian/PI versus URM model, and it was not significant in the white versus URM model. Neither faculty career intention at matriculation nor specialty choice at graduation was a mediator in either model. These variables were excluded from further mediation analysis.

Large mediating effects were observed for MCAT and Step 1 scores, alone and in a block (model 12; Table 5).

For both race/ethnicity comparisons, the analyses of blocks of research experiences (model 13) and of authorship during medical school, research during GME, and faculty career intention at graduation (model 14) indicated a cumulative effect over the simple mediating effects of any one of these variables alone. Including all the significant mediators in model 15 explained about 66% of the race/ethnicity effect on faculty appointment in the Asian/PI versus URM comparison and 65% of the race/ethnicity effect on faculty appointment in the white versus URM comparison.

Discussion

Given the array of strategies implemented over the past 20 years by numerous institutions and organizations to promote the development of a more racially and ethnically diverse academic medicine workforce,[27–30] one might have expected that the proportion of URM medical school graduates in our sample who had been appointed to full-time faculty positions would have been similar to, if not even higher than, the proportions of white and Asian/PI graduates who had been appointed to such positions. However, the proportion of URM graduates who entered academic medicine was substantially *lower* than that of white and of Asian/PI graduates. We identified several factors associated with full-time faculty appointment (Table 4) that served as mediators of the racial/ethnic disparities in this outcome, including academic achievement in the basic sciences (measured using most recent MCAT and first-attempt USMLE Step 1 scores) and participation in research opportunities at various times along the postsecondary educational continuum (Table 5). These findings can inform the development of strategies to increase academic medicine workforce diversity through increasing interest in and preparation for academic medicine careers among diverse medical students and residents.[31]

Strikingly, academic achievement in the basic sciences largely explained the observed effect of race/ethnicity on full-time faculty appointment in both the Asian/PI versus URM and white versus URM models. These findings support the thesis that disparities in academic achievement contribute to lower participation of URM physicians in academic medicine compared with Asian/PI and white physicians.[8,9] An institutional focus on recruitment of medical students and residents with the highest standardized test scores[31] likely also acts as a barrier to achieving a more

Table 4

Logistic Regression Models Testing the Effects of Each of the Potential Mediators on Full-Time Faculty Appointment for Each Race/Ethnicity Comparison (Path B) Among 1998–2004 Graduates of U.S. Liaison Committee on Medical Education (LCME)–Accredited Medical Schools (N = 62,749)*

	Full-time faculty appointment, AOR (95% CI)†	
Potential mediators	Asian/PI versus URM n = 20,016	White versus URM n = 51,452
MCAT score‡	1.053 (1.045–1.061)	1.059 (1.053–1.065)
Faculty career intention at matriculation		
No	1.000 (reference)	1.000 (reference)
Yes	1.721 (1.562–1.898)	1.972 (1.852–2.105)
College research apprenticeship		
No	1.000 (reference)	1.000 (reference)
Yes	1.240 (1.150–1.337)	1.251 (1.195–1.310)
Medical school research elective		
No	1.000 (reference)	1.000 (reference)
Yes	1.337 (1.238–1.443)	1.375 (1.313–1.440)
Authorship during medical school		
No	1.000 (reference)	1.000 (reference)
Yes	1.381 (1.279–1.492)	1.382 (1.318–1.449)
Research during GME		
No	1.000 (reference)	1.000 (reference)
Yes	1.889 (1.692–2.108)	2.208 (2.061–2.365)
USMLE Step 1 score§	1.013 (1.011–1.014)	1.014 (1.013–1.015)
Total debt at graduation¶	0.942 (0.913–0.971)	1.006 (0.987–1.025)
Research-intensive medical school		
No	1.000 (reference)	1.000 (reference)
Yes	1.524 (1.413–1.645)	1.401 (1.336–1.468)
Faculty career intention at graduation		
No	1.000 (reference)	1.000 (reference)
Yes	2.512 (2.326–2.714)	2.690 (2.563–2.823)
Specialty choice at graduation		
IM/Peds/IM&Peds	1.000 (reference)	1.000 (reference)
Family medicine	0.289 (0.237–0.351)	0.225 (0.202–0.250)
Surgery/surgery specialties	0.882 (0.775–1.004)	0.645 (0.596–0.698)
No specialty selected	0.715 (0.622–0.822)	0.681 (0.622–0.745)
All other specialties	0.956 (0.876–1.044)	0.789 (0.748–0.833)

*The database included graduates of all U.S. LCME-accredited medical schools including those in Hawaii and Puerto Rico; the sample included graduates who completed graduate medical education (GME) before 2009. AOR indicates adjusted odds ratio; CI, confidence interval; PI, Pacific Islander; URM, underrepresented minority; MCAT, Medical College Admission Test; USMLE, United States Medical Licensing Examination; IM, internal medicine; Peds, pediatrics.

† Each model is adjusted for confounding variables, gender, parent occupation, and year of graduation; 95% CIs that include the value 1.000 are not statistically significant.

‡ In the Asian/PI versus URM and white versus URM models, AOR > 1.000 indicates a greater likelihood of full-time faculty appointment among Asian/PI (and white) compared with URM graduates for each one-point-unit increase in most-recent-attempt MCAT score.

§ In the Asian/PI versus URM and white versus URM models, AOR > 1.000 indicates a greater likelihood of full-time faculty appointment among Asian/PI (and white) compared with URM graduates for each one-point-unit increase in first-attempt Step 1 score.

¶ In the Asian/PI versus URM model, AOR < 1.000 indicates a lower likelihood of full-time faculty appointment among Asian/PI compared with URM graduates for each $50,000-unit increase in debt. In the white versus URM model, debt was not a significant predictor of full-time faculty appointment.

Table 5

Proportion of Treatment Effect (PTE) of Race/Ethnicity on Full-Time Faculty Appointment Explained by Each of the Mediators in Separate Models and by Blocks of Correlated Mediators Identified as Significant in the Single-Mediator Models, Among 1998–2004 Graduates of U.S. Liaison Committee on Medical Education (LCME)–Accredited Medical Schools (N = 62,749)*

	Asian/PI versus URM n = 20,016		White versus URM n = 51,452	
Models	**PTE (95% CI)**	***P* value**	**PTE (95% CI)**	***P* value**
Single-mediator models				
1. College research apprenticeship	16.04 (8.22 to 23.86)	<.0001	Not a mediator†	
2. MCAT score (most recent attempt)	57.91 (43.41 to 72.42)	<.0001	91.99 (78.37 to 100.00)	<.0001
3. Faculty career intention at matriculation	Not a mediator		Not a mediator	
4. Medical school research elective	18.52 (12.14 to 24.90)	<.0001	Not a mediator†	
5. Authorship during medical school	17.01 (11.03 to 22.98)	<.0001	20.03 (15.08 to 24.97)	<.0001
6. Research during GME	15.72 (10.69 to 20.75)	<.0001	22.36 (17.41 to 27.32)	<.0001
7. USMLE Step 1 score (first attempt)	34.10 (25.71 to 42.48)	<.0001	73.28 (62.72 to 83.85)	<.0001
8. Total debt at graduation	Not a mediator		3.43 (–3.59 to 10.45)	.3381
9. Research-intensive medical school	24.24 (16.99 to 31.48)	<.0001	24.51 (18.70 to 30.32)	<.0001
10. Faculty career intention at graduation	52.06 (39.69 to 64.43)	<.0001	49.14 (40.52 to 57.77)	<.0001
11. Specialty choice at graduation	Not a mediator		Not a mediator	
Blocks of mediators in a model				
12. MCAT and USMLE Step 1 scores	64.70 (45.80 to 83.59)	<.0001	91.82 (78.01 to 100.00)	<.0001
13. All research experiences: college research apprenticeship, medical school research elective, authorship, research during GME	40.77 (29.48 to 52.06)	<.0001	36.39 (29.10 to 43.68)‡	<.0001
14. Authorship, research during GME, and faculty career intention at graduation	61.80 (47.66 to 75.93)	<.0001	61.16 (51.20 to 71.12)	<.0001
15. All significant mediators included	66.05 (44.68 to 87.41)§	<.0001	64.78 (52.19 to 77.37)¶	<.0001

*Each model was controlled for confounders, gender, parent occupation, and year of graduation. The database included graduates of all U.S. LCME-accredited medical schools including those in Hawaii and Puerto Rico; the sample included graduates who completed graduate medical education (GME) before 2009. PI indicates Pacific Islander; URM, underrepresented minority; CI, confidence interval; MCAT, Medical College Admission Test; USMLE, United States Medical Licensing Examination.

† Not a mediator because URM graduates were more likely than white graduates to have participated in these activities (presumed direction of the association is the opposite of observed direction).

‡ Total effect of all mediators in this block model excluded college research apprenticeship and medical school research elective because these variables were not considered to be mediators.

§ Total effect of all mediators in this model excluded faculty career intention at matriculation, total debt at graduation, and specialty choice at graduation because these variables were not mediators in the single-mediator models.

¶ Total effect of all mediators in this model excluded college research apprenticeship, faculty career intention at matriculation, medical school research elective, total debt at graduation, and specialty choice at graduation because these variables were either not mediators or not significant mediators in the single-mediator models.

racially and ethnically diverse academic medicine workforce.

As we hypothesized, research experiences also mediated racial/ethnic disparities in full-time faculty appointments. Our observation that, among URM graduates, participation in a college research apprenticeship was positively associated with having held a faculty appointment (AOR, 1.158; Table 2) extends the evidence for college research program participation in promoting the professional development of those participants who go on to enroll in medical school. Two studies[32,33] previously reported that participation in a formal research program prior to medical school was associated with significantly fewer suboptimal outcomes in medical school (e.g., course/examination failures, attrition). College research apprenticeship participation—which was also a mediator in the Asian/PI versus URM model—may be particularly valuable for URM students who aspire to careers in medicine, as such experiences contribute both to students' success in medical school and, as our findings suggest, to the greater likelihood that they will enter academic medicine careers.

In addition, participation in a medical school research elective mediated the effect of race/ethnicity on full-time faculty appointment in the Asian/PI versus URM comparisons, whereas participating in research during GME mediated the effect of race/ethnicity in both the Asian/PI versus URM and the white versus URM comparisons. A number of funding organizations and medical schools offer opportunities for interested medical students to conduct biomedical research with established investigators.[34,35] There also are funded research opportunities explicitly intended for interested URM students.[36,37] Our study suggests that encouraging URM students to participate in such research opportunities could help reduce racial/ethnic disparities in the academic medicine workforce. Moreover, even though individual research experiences were independently associated with faculty appointment in the regression

models shown in Table 4, having multiple research experiences accounted for a greater PTE of race/ethnicity on faculty appointment in the mediation analysis (block model 13).

Our regression and mediation analyses also suggest that encouraging URM graduates to participate in GME research opportunities could help reduce academic medicine workforce racial/ethnic disparities. We found that a very low proportion of medical school graduates planning careers in family medicine had participated in research during GME, and AMA data indicate that only 6.8% of residents who completed training in family medicine in 2010 planned to pursue academic medicine careers.[38] Targeting research opportunities to residents in specialties such as family medicine, in which URM physicians are overrepresented relative to their representation in the overall GME workforce,[20] might be particularly fruitful.

Authorship of a paper submitted for publication during medical school also explained the association between race/ethnicity and full-time faculty appointment in both the Asian/PI versus URM and the white versus URM comparisons. Notably, although a lower proportion of white than URM graduates reported having participated in a research elective during medical school, a higher proportion of white than URM graduates reported authorship. Similar racial/ethnic disparities in publishing peer-reviewed articles in science and mathematics have been reported previously.[39] There may be racial/ethnic disparities in aspects of medical school research experiences that impede URM students from gaining recognition for their research efforts through authorship on a manuscript. Thus, recent efforts to increase URM medical students' and residents' interest in and success in publishing their research[31] seem both timely and warranted.

That graduation from a research-intensive medical school mediated the relationship between race/ethnicity and full-time faculty appointment suggests that there may be aspects of the environment at such schools—beyond the elective research opportunities offered to students—that influence students' pursuit of academic careers. Efforts to increase the diversity of the academic medicine workforce might be bolstered through innovative, cross-institutional partnerships between research-intensive and other urban medical institutions aimed at promoting biomedical research collaborations. The Meharry–Vanderbilt Alliance[40] and U-HEALTH (Universities for Health Equity through Alignment, Leadership, and Transformation of the Healthcare Workforce)—a collaboration among the AAMC, the Coalition of Urban Serving Universities/Association of Public and Land-grant Universities, and the NIH's National Institute on Minority Health and Health Disparities[1]—are examples of partnerships that could lead to increases in the diversity of the academic medicine workforce.

Full-time faculty career intentions at graduation also mediated the relationship between race/ethnicity and full-time faculty appointment in our models. That the relationship between faculty career intention and faculty appointment was so strong is not surprising; behavioral theory has shown repeatedly that intention to engage in a specific behavior is highly predictive of future engagement in that behavior.[41] Importantly, however, only students who are aware of the possibility of an academic career path can aspire to it and make deliberate plans to achieve it. Thus, expanding the scope of career development programs offered during medical school to include information about academic medicine careers (e.g., the AAMC Careers in Medicine program[42]) could be especially important for URM students beca use lack of awareness of such career opportunities has been cited specifically as a barrier to achieving greater faculty diversity in academic medicine.[8,43] Programs to promote and sustain interest in academic medicine careers among URM students during medical school would be helpful in this regard.[12,31]

The strengths of our study include the longitudinal data analysis of a large, national cohort of medical school graduates' individualized records, including faculty appointment data at all U.S. LCME-accredited medical schools—even historically black and Puerto Rican medical schools, which were excluded from some earlier workforce diversity studies.[10,11] We had race/ethnicity data for 99% of all 1994–2000 matriculants, and we observed some differences in the Asian/PI versus URM and white versus URM comparisons, providing a more nuanced understanding of racial/ethnic differences in the context of academic medicine diversity than has been reported previously in studies that combined Asian/PI and URM faculty as a nonwhite group.[44–47] As a caveat, it is important to remember that with very large samples, such as ours, it is best to consider the magnitude of associations rather than merely the significance of statistical tests. Further investigation is warranted to examine academic medicine career paths of each of the URM racial/ethnic subgroups using national cohort data to better focus efforts to prepare specific subgroups of URM students to pursue academic medicine careers.

Our study had limitations as well. We included only MD degree graduates of LCME-accredited medical schools in the United States; therefore, our findings may not be generalizable to graduates of other types of degree programs (e.g., MD/PhD or MD/other advanced degree) or other types of medical schools (e.g., osteopathic or international). Because our study was observational, causality cannot be inferred from the associations we observed. There are undoubtedly other, unmeasured factors that mediate the association between race/ethnicity and full-time faculty appointment. We lacked medical-school-specific and GME-program-specific information and information regarding participation in particular types of college research experiences, which vary substantially in design, duration, and content.[48] We also did not have information regarding the duration of medical school research electives,[34] medical schools' requirements for research, or faculty mentoring; a lack of mentoring has been cited as a barrier to the development of a more racially and ethnically diverse workforce.[31,43]

We recognize that the study outcome, full-time faculty appointment, is not determined unilaterally by an individual's choice to pursue this career path. Only individuals who are *offered* full-time faculty positions can be appointed to such positions. Thus, having the career intention to pursue such an appointment is not the same as being offered a position aligned with one's professional goals. In addition, racial/ethnic disparities in full-time faculty retention and promotion[10,11] also contribute to the lack of workforce diversity in academic medicine. Nonetheless, our observations

that academic achievement as well as research experiences before, during, and after medical school partly explained the racial/ethnic disparities in U.S. medical school graduates' full-time academic medicine faculty appointments should be of interest to organizations striving to increase workforce diversity through their funding of biomedical research experiences at various points along the postsecondary educational continuum.[48–50] Our results also can inform the U.S. medical schools' development of educational programs that focus attention and efforts on encouraging medical students from diverse backgrounds to pursue careers in academic medicine.[8,31]

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