

ORIGINAL RESEARCH

Medical Student Factors Associated with Future Office-Based Primary-Care Practice

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Purpose: The shortage of primary-care physicians in the US is exacerbated by declining numbers of US medical-school matriculants planning careers in primary-care specialties (general internal medicine, family medicine, or pediatrics). We examined whether primary-care specialty plans at matriculation, especially in family medicine, would be associated with long-term primary-care practice.

Method: Longitudinal data from multiple sources were obtained from the Association of American Medical Colleges for the national cohort of US MD-granting medical-school matriculants in academic years 1998-1999 through 2000-2001. Graduates from 2002-2013 in office-based practice by May 2020 were included. Using two multivariable logistic regression models, we identified matriculating students' specialty plans and medical-school experiences associated with office-based primary-care (vs nonprimary-care) practice.

Results: Of 48,533 matriculants, 30,079 graduates (45.1% female) had complete data for analysis. Of 10,331 matriculants reporting primary-care specialty plans, 4,177 (40.4%) reported primary-care practice at follow-up. Matriculants reporting primary-care specialty plans, especially in family medicine (versus nonprimary-care specialty plans: Model 1) were more likely to report primary-care practice at follow-up (adjusted odds ratios [aORs] range: 2.11-4.83). Matriculants reporting internal medicine (aOR: 0.44) and pediatrics (aOR: 0.72) plans (versus family medicine plans: Model 2) were less likely to report primary-care practice at follow-up. Graduating students planning to practice in underserved areas and rating some or all primary-care clerkships "Excellent" were more likely to be in primary-care practice.

Conclusions: As early as medical-school matriculation, primary-care specialty plans, particularly in family medicine, were associated with long-term primary-care practice. Evaluations of interventions that promote interest in primary-care practice before and during medical school are warranted.

Keywords: Certification, Clinical Clerkships, Data Set, Family Medicine, Health Workforce, Internal Medicine, Medical Education, Pediatrics, Secondary Data Analysis, Underserved Populations

Introduction

There is a growing US physician-workforce shortage in most medical specialties, especially in primary-care specialties (family medicine, internal medicine, and pediatrics),^{1,2} which will be costly to the nation overall, as countries with strong primary-care systems generally see better health outcomes³ and cost-savings.⁴ Inadequate access to primary-care physicians is associated with poorer health outcomes.^{5,6} Thus, promoting medical-students' interest in primary care is essential to improving the nation's health.

In response to concerns about primary-care physician shortages, many US medical schools have developed innovative programs to increase interest in primary-care specialties.^{7,8} The Education in Pediatrics across the Continuum Initiative allows students to enter a competency-based program, potentially allowing early entry into a pediatrics residency.⁷ Other schools in the Consortium of Accelerated Medical Pathways Programs allow students to complete medical school in three years; at several schools, students can "track" into primary-care specialties at matriculation.⁸ Since entry into these programs reflects early primary-care specialty interest, program success depends on the durability of students' plans for primary-care specialties, which

also depends on the provision of learning environments and experiences during medical school that support and sustain students' interests in primary care.⁹

Previous investigations into specialty choice have been limited to assessing proximal outcomes for primary-care practice, such as graduating students' generalist-career plans or specialty choice,⁹⁻¹³ or residents' future career plans.^{1,14} Few studies investigated the stability of matriculating students' primary-care career or specialty plans through both medical school and residency.^{9,13,15-17} To our knowledge, the durability of primary-care specialty plans at matriculation in association with *long-term* primary-care practice has not been reported. Based on the literature, we expected that students reporting primary-care specialty plans at matriculation, especially in family medicine, would be more likely to engage in primary-care practice at long-term follow-up compared with matriculants reporting nonprimary-care specialty plans.^{9-11,13,17,18} We also aimed to identify variables amenable to intervention that are associated with primary-care specialty choice and practice.^{10,11,19-25}

Methods

We conducted a secondary analysis of individual-level, linked, and de-identified longitudinal data from multiple sources for a national cohort of matriculants in US MD-granting medical schools in three academic years (AYs), 1998-1999, 1999-2000, 2000-2001. The Association of American Medical Colleges (AAMC) provided the investigators with data for a large national cohort study beginning in June 2009 with follow-up data through May 2020. Students in this cohort who graduated in calendar years 2002 through 2013, were in office-based practice at follow-up, and had complete data for analysis were included in the analysis.

Measures

The AAMC provided the authors with data obtained from various sources including the AAMC's American Medical College Application Service, Matriculating Student Questionnaire (MSQ), Graduation Questionnaire (GQ), National Board of Medical Examiners (NBME), and American Medical Association (AMA) Physician Masterfile (now renamed AMA Physician Professional Data). Potential covariates of long-term primary-care practice, our outcome of interest, included demographic characteristics (sex, race/ethnicity, parental education) as well as matriculating students' specialty certification plans, which we used as an indicator for early specialty plans, and the importance students placed on prestige and social responsibility in choosing a medical career at matriculation.¹⁰ Medical school variables examined included students' United States Medical Licensing Examination Step 1 scores, primary-care clerkship ratings, and participation in an elective delivering services to underserved populations, plans to practice in underserved areas, and total debt at graduation. We controlled for graduation year, as more recent students were found to be less

likely to choose primary-care specialties at graduation.¹⁰ We used a conservative definition of our outcome, primary-care practice, using the AMA Physician Masterfile's primary and secondary practice specialty data, as previously described.^{23,24} Details regarding the categorization of our outcome and other variables included in the analysis are found in Appendix 1.

Statistical Analysis

We examined bivariate associations between our outcome, office-based primary-care (vs nonprimary-care) practice at follow-up, and each of different specialty plans at matriculation and other categorical variables using chi-square (χ^2) tests. We tested between-groups differences in means (SD) of the importance students placed on prestige and social responsibility in choosing a medical career by our outcome using one-way analyses of variance. We ran unadjusted binary logistic regression models to assess the association between each potential covariate and our outcome and two multivariable logistic regression models to identify variables independently associated with our outcome, adjusted for all other variables. The only difference between the two multivariable models was that the first model compared each category of students' specialty plans at matriculation against nonprimary-care specialty plans as the reference category, and the second model compared specialty plans at matriculation against family medicine as the reference category. We report the odds ratio and 95% confidence interval for each variable in unadjusted models, and we similarly report the adjusted odds ratio for each variable in the two multivariable models. Two-sided *P* values < .05 were considered statistically significant. All tests were conducted using IBM SPSS Statistics, version 28 (IBM Corp., Armonk, NY).

Washington University's Institutional Review Board determined this research to be nonhuman-subjects research (IRB #201808151). We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.²⁶

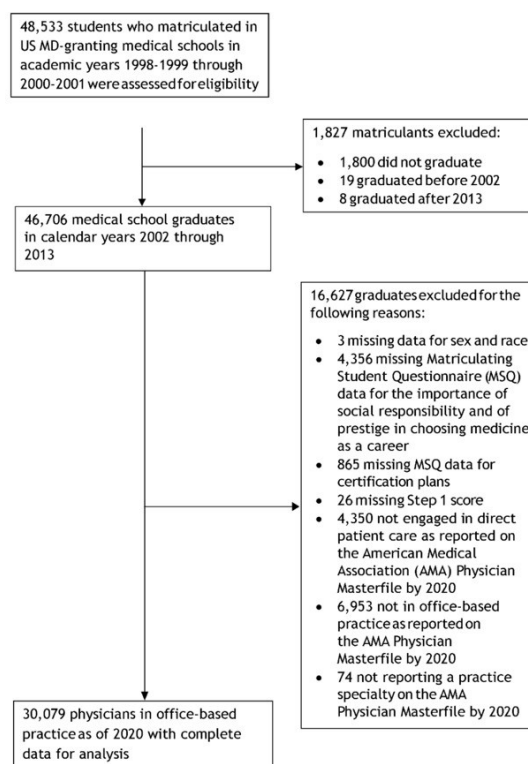
Results

Of 48,533 matriculants in AYs 1998-1999 through 2000-2001, 46,706 graduated in calendar years 2002 through 2013. [Figure 1](#) illustrates how we obtained our analytic sample of 30,079 graduates.

[Table 1](#) displays descriptive statistics for all graduates, grouped by practice-specialty categories. Women constituted 45.1% of the sample and 61.7% of graduates in primary-care practice. Although only 25.3% of the sample reported primary-care practice at follow-up, matriculants with specialty plans in one of the three primary-care specialties overall represented 34.3% of the sample and 54.9% of graduates in primary-care practice.

Notably, a greater proportion of matriculating students with family-medicine specialty plans reported primary-care practice in family medicine at follow-up compared with the proportion of students planning either internal medi-

Figure 1. Flow diagram for cohort eligibility and selection for inclusion in analysis



cine or pediatrics at matriculation who reported primary-care practice in internal medicine or pediatrics, respectively (Figure 2).

All variables were significantly associated with primary-care (vs nonprimary-care) practice in unadjusted logistic regressions models and thus included in the multivariable regression analysis (Table 2). As expected, matriculants with family medicine, internal medicine, and pediatrics specialty plans, and those who were undecided about or had no specialty plans on the MSQ were each more likely than matriculants reporting nonprimary-care specialty plans (the reference category) to report primary-care practice at follow-up. Matriculants reporting family medicine plans were 4.8 times more likely to report primary-care practice than matriculants reporting nonprimary-care specialty plans. We next ran the same multivariable logistic regression model making family medicine the reference category, to further highlight the expected association between reporting family medicine plans at matriculation and future primary-care practice. Here, matriculants who reported internal medicine, pediatrics, and nonprimary-care specialty plans, and who were either undecided or had no specialty plans were each less likely than matriculants with family medicine plans to report primary-care practice at follow-up (Appendix 2). The associations between primary-care prac-

tice and each of the other variables described below were identical to those shown in Table 2.

Among demographic and attitudinal variables at matriculation, female students and first-generation college graduates were more likely to report primary-care practice, whereas students who identified as Asian, URiM, and attributed greater importance of prestige in choosing a medicine career were less likely to report primary-care practice. We observed that students having progressively lower passing quartile and failing Step 1 scores, rating some or all primary-care clerkships “excellent,” planning to practice or being undecided about practicing in underserved areas, and having debt of \$1-149,999 at graduation were more likely to report primary-care practice. The importance of social responsibility in choosing a medicine career, participating in elective/volunteer experiences delivering services to underserved populations, having debt $\geq$ \$150,000, and year of graduation were not significantly associated with primary-care practice in the adjusted model.

Since URiM (vs white) physicians were more likely to report primary-care practice in the unadjusted model but less likely to report primary-care practice in the adjusted model, we examined associations between race/ethnicity and each variable in the fully adjusted model (Table 3). Higher proportions of URiM students reported having primary-care

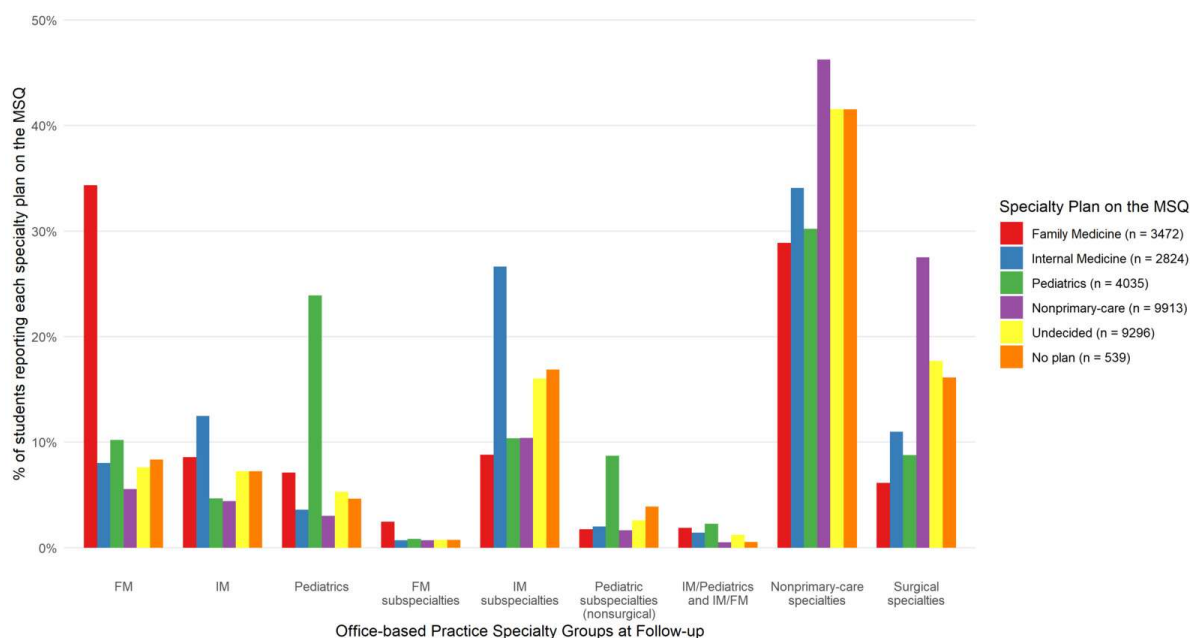
Table 1. Characteristics of the Sample of US Medical School Matriculants in Academic Years 1998-1999 through 2000-2001 Who Graduated in Calendar Years 2002-2013 and Were in Office-Based Practice in Primary-Care or Nonprimary-Care Specialties as of May 2020

	No. (%) ^a		
	Total ^b (n = 30,079)	Primary-care practice ^c (n = 7,605)	Nonprimary-care practice ^c (n = 22,474)
Specialty plans at matriculation			
Family medicine	3,472 (11.5)	1,801 (51.9)	1,671 (48.1)
Internal medicine	2,824 (9.4)	720 (25.5)	2,104 (74.5)
Pediatrics	4,035 (13.4)	1,656 (41.0)	2,379 (59.0)
Nonprimary-care specialties	9,913 (33.0)	1,335 (13.5)	8,578 (86.5)
Undecided	9,296 (30.9)	1,981 (21.3)	7,315 (78.7)
No plans	539 (1.8)	112 (20.8)	427 (79.2)
Sex			
Male	16,521 (54.9)	2,909 (17.6)	13,612 (82.4)
Female	13,558 (45.1)	4,696 (34.6)	8,862 (65.4)
Race/ethnicity			
White	19,752 (65.7)	5,079 (25.7)	14,673 (74.3)
Asian	5,872 (19.5)	1,230 (20.9)	4,642 (79.1)
URiM	4,110 (13.7)	1,227 (29.9)	2,883 (70.1)
Other/unknown/missing	345 (1.1)	69 (20.0)	276 (80.0)
Parent education			
Continuing-generation college graduate	24,327 (80.9)	5,790 (23.8)	18,537 (76.2)
First-generation college graduate	5,611 (18.7)	1,767 (31.5)	3,844 (68.5)
Both parents missing data	141 (0.5)	48 (34.0)	93 (66.0)
First-attempt USMLE Step 1 score, passing quartiles and fail			
Highest quartile	6,888 (22.9)	1,003 (14.6)	5,885 (85.4)
Upper-middle quartile	7,166 (23.8)	1,545 (21.6)	5,621 (78.4)
Lower-middle quartile	7,187 (23.9)	1,964 (27.3)	5,223 (72.7)
Lowest quartile	6,875 (22.9)	2,252 (32.8)	4,623 (67.2)
Fail	1,963 (6.5)	841 (42.8)	1,122 (57.2)
Primary-care clerkships rated excellent			
None	5,917 (19.7)	1,055 (17.8)	4,862 (82.2)
Some (1 or 2)	14,340 (47.7)	3,856 (26.9)	10,484 (73.1)
All (3)	3,170 (10.5)	1,051 (33.2)	2,119 (66.8)
Missing	6,652 (22.1)	1,643 (24.7)	5,009 (75.3)
Deliver services to underserved on elective/volunteer basis			
No	8,209 (27.3)	1,813 (22.1)	6,396 (77.9)
Yes	15,208 (50.6)	4,150 (27.3)	11,058 (72.7)
Missing	6,662 (22.1)	1,642 (24.6)	5,020 (75.4)
Plan to practice in underserved areas			
No	9,353 (31.1)	1,380 (14.8)	7,973 (85.2)
Yes	5,179 (17.2)	2,374 (45.8)	2,805 (54.2)
Undecided	9,658 (32.1)	2,371 (24.5)	7,287 (75.5)
Missing	5,889 (19.6)	1,480 (25.1)	4,409 (74.9)
Total debt at graduation			
\$0	3,756 (12.5)	744 (19.8)	3,012 (80.2)
\$1-\$149,999	15,244 (50.7)	4,115 (27.0)	11,129 (73.0)
≥ \$150,000	5,032 (16.7)	1,217 (24.2)	3,815 (75.8)
Missing	6,047 (20.1)	1,529 (25.3)	4,518 (74.7)
Graduation year^d			
2002-2004	28,080 (93.4)	7,097 (25.3)	20,983 (74.7)
2005-2008	1,904 (6.3)	497 (26.1)	1,407 (73.9)
2009-2013	95 (0.3)	11 (11.6)	84 (88.4)
	Mean (SD) ^e		
Importance of social responsibility	3.4 (0.6)	3.5 (0.5)	3.40 (0.6)
Importance of prestige	2.0 (1.0)	1.9 (1.0)	2.1 (1.0)

^a Pearson chi-square (χ^2) test for each comparison was significant at $P < .001$.^b Percentages of column totals are shown.^c Percentages of row totals are shown.^d Graduation years were clustered to simplify presentation for this table. Each category includes all students in our cohort who matriculated in academic years 1998-1999 through 2000-2001 and graduated in the years specified; students who matriculated in these academic years could have graduated in any one of these three graduation-year categories.

^e One-way analysis of variance for each comparison was significant at $P < .001$; higher mean scores indicate greater importance placed on the items in each measure of social responsibility and prestige in choosing medicine as a career. Abbreviations: URiM = Underrepresented in Medicine, USMLE = United States Medical Licensing Examination, SD = standard deviation.

Figure 2. Percentage of medical students reporting each primary-care or other specialty plan on the Association of American Medical Colleges Matriculating Student Questionnaire (MSQ) in academic years 1998-1999 through 2000-2001, who reported office-based practice on the American Medical Association Physician Masterfile in one of these practice-specialty categories at follow-up in 2020.



Abbreviations: FM = family medicine (including family practice and general practice), IM = internal medicine.

specialty plans at matriculation, elective/volunteer experiences delivering services to underserved populations, plans to practice in underserved areas, $\geq \$150,000$ in debt at graduation, and first-attempt Step 1 failing or lowest-quartile passing scores.

Discussion

To our knowledge, this is the first large-scale, national cohort study to report on medical students' primary-care specialty plans at matriculation in association with long-term primary-care practice outcomes. This study fills a gap in the literature regarding the durability of matriculating medical students' specialty plans and future primary-care practice. Earlier studies were limited by examining surrogate outcomes (eg, estimated percentages of graduates in primary care based on earlier school-level data), specific populations (eg, rural), or outcomes from single or small numbers of institutions.^{9,25,27,28} Our findings have implications for medical-school admissions committees and programs striving to recruit students who will likely engage in primary-care practice, as primary-care specialty plans at matriculation, especially in family medicine, were positively associated with primary-care practice, even after controlling for medical-school experiences. A narrative synthesis of the literature reported on medical-school characteristics

and experiences associated with pursuing primary-care practice,²⁹ however, there is a paucity of research focusing on pre-medical-school experiences or interventions associated with primary-care specialty plans at medical-school matriculation and future primary-care practice. Based on our findings and the literature, we anticipate that early intentions to pursue primary-care practice might be encouraged by engaging in premedical curricula (eg, focusing on public health and health disparities),³⁰ shadowing primary-care physicians, and delivering services to rural and/or urban underserved communities as part of longitudinal clinical and extracurricular experiences.^{15,16} Mission-focused postbaccalaureate programs also can promote interest in and commitment to primary-care practice in underserved areas.³¹

Although higher proportions of URiM students reported primary-care specialty plans at matriculation and primary-care practice at follow-up compared with the other racial/ethnic groups, URiM physicians were unexpectedly less likely to report primary-care practice in the adjusted model. Consistent with other reports, URiM (vs white) physicians in our cohort were more likely to plan to practice in underserved areas,³² and greater proportions of URiM than other racial/ethnic groups of students were first-generation college graduates³³ and scored lower on Step 1.³⁴ Given URiM physicians' historically greater representation in pri-

Table 2. Unadjusted and Adjusted Logistic Regression Models of Specialty Plans at Matriculation, Demographic, Attitudinal, and Medical School Experiential Variables in Association with Primary-Care (vs Nonprimary-Care) Specialty Practice

	No.	Unadjusted models		Adjusted model	
	30,079	OR (95% CI)	P Value	aOR (95% CI)	P Value
Specialty plans at matriculation					
Nonprimary-care specialty	9,913	1.00 (Reference)		1.00 (Reference)	
Family medicine	3,472	6.92 (6.34-7.56)	< .001	4.83 (4.39-5.31)	< .001
Internal medicine	2,824	2.20 (1.98-2.44)	< .001	2.11 (1.89-2.35)	< .001
Pediatrics	4,035	4.47 (4.11-4.87)	< .001	3.46 (3.16-3.79)	< .001
Undecided	9,296	1.74 (1.61-1.88)	< .001	1.71 (1.58-1.85)	< .001
No plans	539	1.68 (1.36-2.09)	< .001	1.59 (1.27-2.00)	< .001
Sex					
Male	16,521	1.00 (Reference)		1.00 (Reference)	
Female	13,558	2.48 (2.35-2.62)	< .001	1.84 (1.74-1.96)	< .001
Race/ethnicity					
White	19,752	1.00 (Reference)		1.00 (Reference)	
Asian	5,872	0.76 (0.71-0.82)	< .001	0.80 (0.74-0.86)	< .001
URiM	4,110	1.23 (1.14-1.32)	< .001	0.70 (0.64-0.77)	< .001
Other/unknown/missing	345	0.72 (0.55-0.94)	.02	0.68 (0.51-0.92)	.01
Parent education					
Continuing-generation college graduate	24,327	1.00 (Reference)		1.00 (Reference)	
First-generation college graduate	5,611	1.47 (1.38-1.57)	< .001	1.24 (1.15-1.33)	< .001
Both parents missing data	141	1.65 (1.16-2.34)	.005	1.45 (0.98-2.14)	.06
Importance of social responsibility ^a	30,079	1.59 (1.51-1.68)	< .001	1.06 (0.998-1.12)	.06
Importance of prestige ^b	30,079	0.77 (0.75-0.80)	< .001	0.92 (0.89-0.95)	< .001
First-attempt USMLE Step 1 score, passing quartiles and fail					
Highest quartile	6,888	1.00 (Reference)		1.00 (Reference)	
Upper-middle quartile	7,166	1.61 (1.48-1.76)	< .001	1.44 (1.32-1.58)	< .001
Lower-middle quartile	7,187	2.21 (2.03-2.40)	< .001	1.87 (1.70-2.04)	< .001
Lowest quartile	6,875	2.86 (2.63-3.11)	< .001	2.38 (2.18-2.61)	< .001
Fail	1,963	4.40 (3.93-4.92)	< .001	3.97 (3.51-4.50)	< .001
Primary-care clerkships rated excellent					
None	5,917	1.00 (Reference)		1.00 (Reference)	
Some (1 or 2)	14,340	1.70 (1.57-1.83)	< .001	1.46 (1.34-1.58)	< .001
All (3)	3,170	2.29 (2.07-2.52)	< .001	1.83 (1.64-2.04)	< .001
Missing	6,652	1.51 (1.39-1.65)	< .001	1.32 (0.78-2.26)	.30
Deliver services to underserved on elective/volunteer basis					
No	8,209	1.00 (Reference)		1.00 (Reference)	
Yes	15,208	1.32 (1.24-1.41)	< .001	0.96 (0.90-1.03)	.28
Missing	6,662	1.15 (1.07-1.24)	< .001	0.81 (0.47-1.41)	.46
Plan to practice in underserved areas					
No	9,353	1.00 (Reference)		1.00 (Reference)	
Yes	5,179	4.89 (4.52-5.29)	< .001	3.21 (2.94-3.51)	< .001
Undecided	9,658	1.88 (1.75-2.02)	< .001	1.52 (1.40-1.64)	< .001
Missing	5,889	1.94 (1.79-2.10)	< .001	1.54 (1.03-2.29)	.04
Total debt at graduation					
\$0	3,756	1.00 (Reference)		1.00 (Reference)	
\$1-\$149,999	15,244	1.50 (1.37-1.63)	< .001	1.19 (1.08-1.31)	< .001
≥ \$150,000	5,032	1.29 (1.16-1.43)	< .001	1.03 (0.92-1.15)	.64
Missing	6,047	1.37 (1.24-1.51)	< .001	1.48 (1.03-2.13)	.03
Graduation year ^c	30,079	0.96 (0.93-0.98)	< .001	0.99 (0.96-1.02)	.43

^a ORs > 1.00 indicate greater likelihood of primary-care practice with each 1-unit increase in importance of social responsibility in choosing medicine as a career at matriculation.

^b ORs < 1.00 indicate lower likelihood of primary-care practice with each 1-unit increase in importance of prestige in choosing medicine as a career at matriculation.

^c ORs < 1.00 indicate lower likelihood of primary-care practice with each more recent year at graduation.

Abbreviations: OR = odds ratio, CI = confidence interval, aOR = adjusted odds ratio, URiM = Underrepresented in Medicine, USMLE = United States Medical Licensing Examination.

Table 3. Characteristics of the Sample in Association with Students' Self-Reported Race/Ethnicity

	No. (%) ^a				
	Total ^b (n = 30,079)	White ^b (n = 19,752)	Asian ^b (n = 5,872)	URiM ^b (n = 4,110)	Other/ unknown ^b (n = 345)
Office-based practice specialty					
Primary care	7,605 (25.3)	5,079 (25.7)	1,230 (20.9)	1,227 (29.9)	69 (20.0)
Nonprimary care	22,474 (74.7)	14,673 (74.3)	4,642 (79.1)	2,883 (70.1)	276 (80.0)
Specialty plans at matriculation					
Family medicine	3,472 (11.5)	2,521 (12.8)	435 (7.4)	485 (11.8)	31 (9.0)
Internal medicine	2,824 (9.4)	1,613 (8.2)	755 (12.9)	428 (10.4)	28 (8.1)
Pediatrics	4,035 (13.4)	2,581 (13.1)	768 (13.1)	642 (15.6)	44 (12.8)
Nonprimary-care specialty	9,913 (33.0)	6,445 (32.6)	1,802 (30.7)	1,564 (38.1)	102 (29.6)
Undecided	9,296 (30.9)	6,243 (31.6)	1,998 (34.0)	922 (22.4)	133 (38.6)
No plans	539 (1.8)	349 (1.8)	114 (1.9)	69 (1.7)	7 (2.0)
Sex					
Male	16,521 (54.9)	11,264 (57.0)	3,238 (55.1)	1,840 (44.8)	179 (51.9)
Female	13,558 (45.1)	8,488 (43.0)	2,634 (44.9)	2,270 (55.2)	166 (48.1)
Parent education					
Continuing-generation college graduate	24,327 (80.9)	16,238 (82.2)	5,111 (87.0)	2,686 (65.4)	292 (84.6)
First-generation college graduate	5,611 (18.7)	3,440 (17.4)	737 (12.6)	1,385 (33.7)	49 (14.2)
Both parents missing data	141 (0.5)	74 (0.4)	24 (0.4)	39 (0.9)	4 (1.2)
First-attempt USMLE Step 1 score, passing quartiles and fail					
Highest quartile	6888 (22.9)	5,119 (25.9)	1306 (22.2)	373 (9.1)	90 (26.1)
Upper-middle quartile	7166 (23.8)	5,040 (25.5)	1437 (24.5)	614 (14.9)	75 (21.7)
Lower-middle quartile	7187 (23.9)	4,820 (24.4)	1414 (24.1)	867 (21.1)	86 (24.9)
Lowest quartile	6875 (22.9)	3,915 (19.8)	1371 (23.3)	1,515 (36.9)	74 (21.4)
Fail	1963 (6.5)	858 (4.3)	344 (5.9)	741 (18.0)	20 (5.8)
Primary-care clerkships rated excellent					
None	5917 (19.7)	3,744 (19.0)	1331 (22.7)	773 (18.8)	69 (20.0)
Some (1 or 2)	14,340 (47.7)	9,753 (49.4)	2,636 (44.9)	1,798 (43.7)	153 (44.3)
All (3)	3170 (10.5)	2,151 (10.9)	545 (9.3)	446 (10.9)	28 (8.1)
Missing	6652 (22.1)	4,104 (20.8)	1360 (23.2)	1,093 (26.6)	95 (27.5)
Deliver services to underserved on elective/volunteer basis					
No	8209 (27.3)	5,726 (29.0)	1,557 (26.5)	812 (19.8)	114 (33.0)
Yes	15,208 (50.6)	9,913 (50.2)	2,949 (50.2)	2,210 (53.8)	136 (39.4)
Missing	6662 (22.1)	4,113 (20.8)	1,366 (23.3)	1,088 (26.5)	95 (27.5)
Plan to practice in underserved areas					
No	9353 (31.1)	6,809 (34.5)	1,863 (31.7)	580 (14.1)	101 (29.3)
Yes	5179 (17.2)	3,116 (15.8)	684 (11.6)	1,335 (32.5)	44 (12.8)
Undecided	9658 (32.1)	6,180 (31.3)	2,122 (36.1)	1,243 (30.2)	113 (32.8)
Missing	5889 (19.6)	3,647 (18.5)	1,203 (20.5)	952 (23.2)	87 (25.2)
Total debt at graduation					
\$0	3756 (12.5)	2,315 (11.7)	1,101 (18.8)	290 (7.1)	50 (14.5)
\$1-\$149,999	15,244 (50.7)	10,311 (52.2)	2,686 (45.7)	2,100 (51.1)	147 (42.6)
≥ \$150,000	5032 (16.7)	3,377 (17.1)	856 (14.6)	742 (18.1)	57 (16.5)
Unknown/missing	6047 (20.1)	3,749 (19.0)	1,229 (20.9)	978 (23.8)	91 (26.4)
	Mean (SD) ^c				
Importance of social responsibility	3.4 (0.5)	3.4 (0.6)	3.5 (0.5)	3.5 (0.5)	3.4 (0.6)
Importance of prestige	2.0 (1.0)	2.0 (1.0)	2.2 (1.0)	2.1 (1.0)	2.1 (1.0)

^a Pearson chi-square (χ^2) test for each comparison was significant at $P < .001$.

^b Percentages shown are of column totals.

^c One-way analysis of variance for each comparison was significant at $P < .001$; higher mean scores indicate greater importance placed on the items in each measure of social responsibility and prestige in choosing medicine as a career.

Abbreviations: URiM = Underrepresented in Medicine, USMLE = United States Medical Licensing Examination, SD = standard deviation.

mary-care practice compared with other practice specialties,³⁵ the associations between race/ethnicity and several variables in the adjusted model likely explain the change in direction of the association between URiM physicians and primary-care practice that was observed in the *unadjusted* model.^{36,37} Analyses of the effects of potential explanatory variables on the association between race/ethnicity and primary-care practice were beyond the scope of this investigation but are warranted. Lastly, the reasons for declining proportions of URiM physicians in primary-care practice, from 44% in 2012¹⁹ to 30% in our cohort sam-

ple—which was only a subset of all primary-care physicians in 2020—deserves investigation, as the health of underserved patients is likely to be most significantly affected by further decline.^{38,39}

First-generation college graduates were more likely to be in primary-care practice in the adjusted model. Little is known about why first-generation college graduates choose certain specialties or career paths. Future studies should seek to better understand this group's affinity for primary-care practice and examine potential socioeconomic challenges that first-generation college graduates may face,

such as the need for employment during college,³³ which may place them at higher risk of academic and health/wellness challenges before⁴⁰ and during^{41,42} medical school. Notably, participants in some diversity-focused, mission-driven postbaccalaureate programs aiming to ameliorate challenges that URiM and first-generation college graduates might face in medical school were more likely to choose primary-care specialties and practice in underserved areas than graduates who did not complete such programs.^{31,43,44} For female physicians, primary care may seem more welcoming given a lack of female role models and mentors in other specialties,⁴⁵ lower pay for women,⁴⁶ and experiences of sexual harassment⁴⁷ throughout their careers. Research should also delve deeper into male students' disinclination toward primary-care practice. Altruistic beliefs about healthcare and greater importance of social responsibility in choosing medicine were previously found to be associated with primary-care specialty choice among graduating students.¹⁰ However, while greater importance of prestige was independently associated with primary-care practice in other studies^{22,48} and ours, the importance of social responsibility was not. Given the small absolute differences observed between physicians in primary-care and nonprimary-care practice, shown here and elsewhere,⁴⁹ the importance of social responsibility may not weigh as heavily in physicians' specialty-practice decision-making as their lived experience.

Among medical-school variables, graduating students who either planned to practice or were undecided about practicing in underserved areas were more likely to report primary-care practice, aligning with other research examining shorter-term outcomes of primary-care specialty choice at graduation and matching to a primary-care residency.^{50, 51} Although we did not observe an association between elective/volunteer experiences delivering services to underserved populations and long-term primary-care practice in the adjusted model, we lacked information about what these experiences entailed and the length of time spent in such elective/volunteer activities. Several programs have successfully fostered pursuit of primary care and practice in underserved areas.^{31,51-53} Whether more substantial interventions, such as longitudinal medical-school pathways emphasizing care for patients in underserved communities, would have a greater impact on pursuing primary-care practice than activities of a shorter duration is an empirical question of interest.

Students who rated some or all primary-care clerkships as excellent were more likely to report primary-care practice at follow-up, extending prior research showing that positive clerkship experiences were associated with specialty choice.^{54,55} This is an important confirmatory finding, as prior investigations have not always controlled for specialty plans at matriculation.^{56,57} Additional research could help clarify specific clerkship components or experiences that influence students' specialty choice decisions, as existing research suggests that students' interactions with residents and attendings may play a larger role (positive or negative) than educational, programmatic clerkship experiences.⁵⁴

Lower Step 1 scores were associated with higher odds of primary-care practice. Historically, more competitive specialties, such as surgery specialties, have required higher Step 1 scores in the match.⁵⁸ Although many students report that Step 1 scores do not impact their initial specialty choice based on the "competitiveness" of the specialty, students may change their specialty choice as a result of their Step 1 results.^{59,60} Future studies of graduating students' specialty choice will likely control for the effects of student's Step 2CK clinical knowledge scores and their medical school's "prestige," as program directors have indicated they would likely place greater importance on these factors for resident-interview selection after Step 1 scoring changed to pass/fail.⁶¹

We found that, compared with no debt at graduation, physicians with \$1-\$149,999 total debt were more likely to be in primary-care practice, but physicians with higher debt at graduation were not. The reasons for this observation are unclear. There may be complex interactions between debt and other variables that moderate an individual's tolerance for debt,²² some of which may relate to premedical educational debt, family socioeconomic status, and/or career preferences that affect future earning potential.⁴¹ Given that most medical graduates report that educational debt and income potential play little or no role in specialty-choice decisions compared with other factors, such as specialty content, role models, and graduates' interests and values placed on "work-life balance" considerations,⁶² we might consider earmarking funds to identify, encourage, and support students interested in primary care, who might otherwise discount careers in medicine due to financial hardship.

A strength of our study is the large, national cohort database, allowing examination of several variables of interest along the medical-education continuum in association with long-term primary-care practice. Given the gap in time between data receipt and reporting these results, our findings might not reflect recent changes in primary-care practice since the pandemic. However, we would still expect to observe significant associations between primary-care practice and many of the variables we examined, based on earlier studies of primary-care specialty choice at graduation and residents' career plans.^{9,10,13,15-17} Other limitations include the inability to infer causation from observed associations; and since we included only US graduates from MD-granting medical schools, results may not be generalizable to osteopathic or international medical-school graduates. As the study included only office-based practitioners, our findings are not generalizable to hospital-based physicians who trained in traditional primary-care specialties. Further, because we did not consider physicians who reported primary or secondary practice in family medicine, internal medicine, or pediatrics subspecialties as primary-care physicians, we likely underestimated the number of primary-care physicians in this cohort. We could not account for generalist or subspecialty practice plans at matriculation as our dataset did not contain this information. However, we would expect an even stronger association between primary-care practice plans at matriculation and

future primary-care practice, given the sizeable associations we observed between primary-care specialty plans at matriculation and future primary-care practice. Although MSQ response rates (AYs 1998-1999 through 2000-2001) averaged 92.0% (83.2%-96.5%), GQ response rates (AYs 2001-2002 through 2012-2013) averaged 69.5% (32.6%-90.1%), with considerable fluctuation (D. Matthew, PhD. Association of American Medical Colleges, email communication, August 30, 2022). Thus, we added a “Missing” category for GQ variables to reduce the possible risk of bias due to missing data. Additionally, we combined URiM groups for analysis, potentially masking differences among these groups. However, larger proportions of each of the URiM groups historically have engaged in primary-care practice in the US compared with other racial/ethnic physician groups,³⁵ justifying aggregation for analysis.

Conclusion

Nevertheless, matriculating-students’ primary-care specialty plans, especially in family medicine, and several modifiable medical-school experiences were positively associated with primary-care practice. Medical schools and other stakeholders interested in recruiting and training more primary-care physicians should expand their efforts and outreach, even before medical school, to engage students interested in medicine in targeted academic and extracurricular experiences that involve working with underserved populations living in areas with limited access to healthcare. Such premedical programs and experiences would help increase the numbers of students interested in primary-care specialties at medical-school matriculation. By pairing recruitment and curricular interventions, we should be able to increase the size of the primary-care-physician workforce.

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Conflicts of Interest

None.

Disclaimers

This study used raw data provided by the Association of American Medical Colleges (AAMC), National Board of Medical Examiners (NBME), and American Medical Association (AMA). No US Census Bureau data were used in the production of this paper. The statistical analyses, interpretation of findings, opinions, and conclusions expressed herein are those of the authors and do not necessarily reflect the views, position, or policy of the AAMC, NBME, AMA, NIH NIGMS, or US Census Bureau, or their respective staff members. The NIH NIGMS was not involved in the design or conduct of the study; collection, management, analysis, or interpretation of the data; or in the preparation, review, or approval of the manuscript.

Data Availability

Data for this study are proprietary and used by the authors with permission under data-use agreements with the AAMC, AMA, and NBME. Data may be made available to investigators for their research by submitting a request to the AAMC and/or other data sources.

Previous Presentations

Preliminary findings were presented at the Association of American Medical Colleges Central Group on Educational Affairs Annual Meeting Conference (Virtual), March 30-31, 2022, and at Learn Serve Lead 2022: The AAMC Annual Meeting, Nashville, TN, November 11-15, 2022.

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Appendices

Appendix 1. Measures

From the AAMC's American Medical College Application Service (AAMC, Washington, DC), we received data for sex (male or female) and race/ethnicity. For analysis, we created a 4-category variable for race/ethnicity: White; Asian; other/unknown; or underrepresented groups in medicine (URiM), including Black/African American, Hispanic, Native Hawaiian/Pacific Islander, and American Indian/Alaskan Native. From the AAMC Student Records System, we received data for matriculation and graduation dates.

For our cohort matriculating in academic years (AYs) 1998-1999 through 2000-2001, the AAMC's Matriculating Student Questionnaire (MSQ) asked students, "Are you planning to become certified in one of the 25 general specialties listed below?" Students could respond "No," "Undecided," and "Yes." Only if students answered "Yes" were they offered the opportunity to answer the next question, "If Yes, what general specialty are you considering?" Response options included 25 specialties for certification by each of the 24 American Board of Medical Specialties member boards, with neurology and psychiatry each certified by the American Board of Psychiatry and Neurology. Responses from these two MSQ items were used to create a 6-category variable for specialty plans at matriculation: considering one of the primary-care specialties (ie, family medicine, internal medicine, or pediatrics); any nonprimary-care specialty; undecided about a specialty; or having no specialty plans.

We also created a 3-category variable based on MSQ items about parent education: first-generation college graduate (neither mother nor father received a bachelor's degree); continuing-generation college graduate (one or both parents received at least a bachelor's degree); or missing data for both parents. We also included two multi-item measures of student ratings of the importance of prestige and of social responsibility in choosing medicine as a career; mean scores range from not important (1) to very important (4).

On the AAMC's Graduation Questionnaire (GQ), students were asked to "Rate the quality of your educational experience in each of the following clinical clerkships," followed by a list of clinical clerkships. Using students' ratings of each of "Family-community medicine," "Internal medicine," and "Pediatrics" clerkships (response options: poor, fair, good, or excellent), we created a 4-category variable for the number of primary-care clerkships rated excellent: none; some (one or two); all (three); or missing. We also created a 4-category variable for intention to practice in underserved areas ("Do you plan to practice in an underserved area?"; yes, no, undecided, or missing), a 3-category variable for reporting elective/volunteer experiences delivering services to underserved populations ("Indicate the activities you will have participated in during medical school on an elective or volunteer [not required] basis: Delivering Health Services To Underserved Populations"; yes, no, missing), and a 4-category variable for total educational

debt at graduation (sum of premedical school and medical school debt; \$0; \$1-149,999; $\geq$ \$150,000; missing). For each GQ variable, we included a missing category for analysis to minimize the risk of bias by excluding students who either did not answer a GQ item or did not complete the GQ.

With permission from the National Board of Medical Examiners (NBME), the AAMC provided first-attempt United States Medical Licensing Examination (USMLE) Step 1 scores for individuals in this cohort. For analysis, we created a 5-category variable for first-attempt failing and passing quartile scores (calculated separately for each annual cohort to account for yearly variation in passing scores).

We also received American Medical Association (AMA) Physician Masterfile data (now known as AMA Physician Professional Data), including primary type of practice, practice setting, and primary and secondary practice specialties. The data we received in June 2020 included the most recent AMA Physician Masterfile data available for all individuals in our cohort. Among physicians reporting primary type of practice in direct patient care, our long-term outcome of interest was office-based primary-care specialty (vs nonprimary-care specialty) practice. Primary-care practice was conservatively defined to include only physicians whose primary practice specialty was family medicine, internal medicine, pediatrics, internal medicine-pediatrics, internal medicine-family practice, or general practice and whose secondary practice specialty was either another primary-care specialty or no secondary specialty was reported. Thus, we compared physicians in primary-care practice with physicians practicing in any nonprimary-care specialty, including subspecialties of family medicine, internal medicine, and pediatrics.

Appendix 2. Unadjusted and Adjusted Logistic Regression Models of Specialty Plans at Matriculation, Demographic, Attitudinal, and Medical School Experiential Variables in Association with Primary-Care (vs Nonprimary-Care) Specialty Practice at Follow-Up

	No.	Unadjusted models		Adjusted model	
	30,079	OR (95% CI)	P Value	aOR (95% CI)	P Value
Specialty plans at matriculation					
Family medicine	3,472	1.00 (Reference)		1.00 (Reference)	
Nonprimary-care specialty	9,913	0.14 (0.13-0.16)	< .001	0.21 (0.19-0.23)	< .001
Internal medicine	2,824	0.32 (0.28-0.35)	< .001	0.44 (0.39-0.49)	< .001
Pediatrics	4,035	0.65 (0.59-0.71)	< .001	0.72 (0.65-0.79)	< .001
Undecided	9,296	0.25 (0.23-0.27)	< .001	0.35 (0.32-0.39)	< .001
No plans	539	0.24 (0.20-0.30)	< .001	0.33 (0.26-0.42)	< .001
Sex					
Male	16,521	1.00 (Reference)		1.00 (Reference)	
Female	13,558	2.48 (2.35-2.62)	< .001	1.84 (1.74-1.96)	< .001
Race/ethnicity					
White	19,752	1.00 (Reference)		1.00 (Reference)	
Asian	5,872	0.76 (0.71-0.82)	< .001	0.80 (0.74-0.86)	< .001
URiM	4,110	1.23 (1.14-1.32)	< .001	0.70 (0.64-0.77)	< .001
Other/unknown/missing	345	0.72 (0.55-0.94)	.02	0.68 (0.51-0.92)	.01
Parent education					
Continuing-generation college graduate	24,327	1.00 (Reference)		1.00 (Reference)	
First-generation college graduate	5,611	1.47 (1.38-1.57)	< .001	1.24 (1.15-1.33)	< .001
Both parents missing data	141	1.65 (1.16-2.34)	.005	1.45 (0.98-2.14)	.06
Importance of social responsibility ^a	30,079	1.59 (1.51-1.68)	< .001	1.06 (0.998-1.12)	.06
Importance of prestige ^b	30,079	0.77 (0.75-0.80)	< .001	0.92 (0.89-0.95)	< .001
First-attempt USMLE Step 1 score, passing quartiles and fail					
Highest quartile	6,888	1.00 (Reference)		1.00 (Reference)	
Upper-middle quartile	7,166	1.61 (1.48-1.76)	< .001	1.44 (1.32-1.58)	< .001
Lower-middle quartile	7,187	2.21 (2.03-2.40)	< .001	1.87 (1.70-2.04)	< .001
Lowest quartile	6,875	2.86 (2.63-3.11)	< .001	2.38 (2.18-2.61)	< .001
Fail	1,963	4.40 (3.93-4.92)	< .001	3.97 (3.51-4.50)	< .001
Primary-care clerkships rated excellent					
None	5,917	1.00 (Reference)		1.00 (Reference)	
Some (1 or 2)	14,340	1.70 (1.57-1.83)	< .001	1.46 (1.34-1.58)	< .001
All (3)	3,170	2.29 (2.07-2.52)	< .001	1.83 (1.64-2.04)	< .001
Missing	6,652	1.51 (1.39-1.65)	< .001	1.32 (0.78-2.26)	.30
Deliver services to underserved on elective/volunteer basis					
No	8,209	1.00 (Reference)		1.00 (Reference)	
Yes	15,208	1.32 (1.24-1.41)	< .001	0.96 (0.90-1.03)	.28
Missing	6,662	1.15 (1.07-1.24)	< .001	0.81 (0.47-1.41)	.46
Plan to practice in underserved areas					
No	9,353	1.00 (Reference)		1.00 (Reference)	
Yes	5,179	4.89 (4.52-5.29)	< .001	3.21 (2.94-3.51)	< .001
Undecided	9,658	1.88 (1.75-2.02)	< .001	1.52 (1.40-1.64)	< .001
Missing	5,889	1.94 (1.79-2.10)	< .001	1.54 (1.03-2.29)	.04
Total debt at graduation					
\$0	3,756	1.00 (Reference)		1.00 (Reference)	
\$1-\$149,999	15,244	1.50 (1.37-1.63)	< .001	1.19 (1.08-1.31)	< .001
≥ \$150,000	5,032	1.29 (1.16-1.43)	< .001	1.03 (0.92-1.15)	.64
Missing	6,047	1.37 (1.24-1.51)	< .001	1.48 (1.03-2.13)	.03
Graduation year ^c	30,079	0.96 (0.93-0.98)	< .001	0.99 (0.96-1.02)	.43

^a ORs > 1.00 indicate greater likelihood of primary-care practice with each 1-unit increase in importance of social responsibility in choosing medicine as a career at matriculation.

^b ORs < 1.00 indicate lower likelihood of primary-care practice with each 1-unit increase in importance of prestige in choosing medicine as a career at matriculation.

^c ORs < 1.00 indicate lower likelihood of primary-care practice with each more recent year at graduation.

Abbreviations: OR = odds ratio, CI = confidence interval, aOR = adjusted odds ratio, URiM = Underrepresented in Medicine, USMLE = United States Medical Licensing Examination.