Factors Associated With American Board of Medical Specialties Member Board Certification Among US Medical School Graduates

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Context Certification by an American Board of Medical Specialties (ABMS) member board is emerging as a measure of physician quality.

Objective To identify demographic and educational factors associated with ABMS member board certification of US medical school graduates.

Design, Setting, and Participants Retrospective study of a national cohort of 1997-2000 US medical school graduates, grouped by specialty choice at graduation and followed up through March 2, 2009. In separate multivariable logistic regression models for each specialty category, factors associated with ABMS member board certification were identified.

Main Outcome Measure ABMS member board certification.

Results Of 42 440 graduates in the study sample, 37 054 (87.3%) were board certified. Graduates in all specialty categories with first-attempt passing scores in the highest tertile (vs first-attempt failing scores) on US Medical Licensing Examination Step 2 Clinical Knowledge were more likely to be board certified; adjusted odds ratios (AORs) varied by specialty category, with the lowest odds for emergency medicine (87.4% vs 73.6%; AOR, 1.82; 95% CI, 1.03-3.20) and highest odds for radiology (98.1% vs 74.9%; AOR, 13.19; 95% CI, 5.55-31.32). In each specialty category except family medicine, graduates self-identified as underrepresented racial/ethnic minorities (vs white) were less likely to be board certified, ranging from 83.5% vs 95.6% in the pediatrics category (AOR, 0.44; 95% CI, 0.33-0.58) to 71.5% vs 83.7% in the other nongeneralist specialties category (AOR, 0.79; 95% CI, 0.64-0.96). With each $50 000 unit increase in debt (vs no debt), graduates choosing obstetrics/gynecology were less likely to be board certified (AOR, 0.89; 95% CI, 0.83-0.96), and graduates choosing family medicine were more likely to be board certified (AOR, 1.13; 95% CI, 1.01-1.26).

Conclusion Demographic and educational factors were associated with board certification among US medical school graduates in every specialty category examined; findings varied among specialty categories.

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SPECIALTY-BOARD CERTIFICATION by an American Board of Medical Specialties (ABMS) member board is an increasingly important credential for physicians engaged in clinical practice. Although lack of ABMS board certification does not necessarily mean that a physician is not well qualified,[1,2] its presence is associated with the quality of medical care that physicians deliver to their patients.[3-5] Better patient outcomes have been observed for patients under the care of board-certified physicians compared with those under the care of non–board-certified physicians.[5-8] American Board of Medical Specialties member board certification[9] and higher scores on certifying examinations among physicians certified by the American Board of Internal Medicine[10] also have been associated with lower risk of physician disciplinary action, whereas lack of board certification has been associated with higher risk of such disciplinary actions as license revocation, practice suspension, probation, and public reprimand.[11]

American Board of Medical Specialties member board certification is currently among the criteria used by health maintenance organizations, hospitals, and health insurance plans in evaluating physicians who wish to obtain privileges or join provider organizations,[7,12] by medical school promotion committees in evaluating physician faculty members for promotion and tenure,[13,14] and by the Accreditation Council for Graduate Medical Education as criteria for selection of physicians to serve as graduate medical education (GME) program directors and residency review committee members.[15,16] Thus, ABMS member board certification is emerging as a de facto requirement for the full participation of physicians in the US health care system, and non–board-certified physicians compose an increasingly

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marginalized group. We therefore sought to identify demographic, medical school, and GME variables associated with ABMS member board certification among a national cohort of US Liaison Committee on Medical Education–accredited medical school graduates.

METHODS

After obtaining institutional review board approval at Washington University School of Medicine (nonhuman subjects research with waiver of consent), we constructed a database with individually linked, deidentified records for all 1993-2000 Liaison Committee on Medical Education–accredited US medical school matriculants who graduated from 1997 to 2000. Follow-up data through March 2, 2009, allowed more than 8 years of follow-up for all graduates in our database. The database included selected items from the Association of American Medical Colleges (AAMC) Student Record System; first-attempt US Medical Licensing Examination Step 1 and Step 2 Clinical Knowledge results, which were released with permission from the National Board of Medical Examiners; the AAMC Graduation Questionnaire; the AAMC GME Track; and the American Medical Association (AMA) Physician Masterfile.

The AAMC Graduation Questionnaire is administered voluntarily and confidentially to medical school graduates annually.[17] Overall response rates among graduates in the 1997-2000 graduating classes ranged from 81% in 1999 to 91% in 2000.[18-22]

The AAMC GME Track database contains the annual National GME Census data from all Accreditation Council for Graduate Medical Education–accredited programs; this census is conducted jointly by the AAMC and the AMA,[23,24] with high completion rates. The training status was confirmed by program directors for 96% of all physicians in the GME Census database in the 2009-2010 academic year.[24]

American Medical Association Physician Masterfile data pertaining to active state medical licenses are provided by state licensing boards to the AMA and updated by these boards at least biannually.[25] We used these licensing data to identify non–board-certified graduates in our study sample who were actively licensed as of March 2, 2009.

Predictor Variables

Demographic variables included graduation date and students' sex and self-identified race/ethnicity as reported on the American Medical College Application Service questionnaire. We categorized race/ethnicity as Asian/Pacific Islander, underrepresented minority in medicine (including Hispanic, black, American Indian, or Alaska Native), other/unknown (including graduates who self-identified as other or multiple races or who did not respond to this question), or white (reference group). We examined race/ethnicity because board certification rates were reportedly lower among nonwhite compared with white physicians.[4,26-29]

We also included Graduation Questionnaire variables for graduates' age at graduation (<28 years vs ≥28 years), total debt, and planned specialty for board certification. Total debt at graduation was categorized as no debt, $1 to $49 999, $50 000 to $99 999, $100 000 to $149 999, and $150 000 or more. We included only graduates who answered yes to the Graduation Questionnaire item "Do you plan to become certified in a specialty?" and selected a planned specialty for board certification; questionnaire respondents who answered no or undecided to this item were not offered the opportunity on the Graduation Questionnaire to choose a specialty. Questionnaire respondents who planned to become certified in a chosen specialty/subspecialty were assigned to 1 of 8 specialty categories according to ABMS member board clinical and oral examination requirements for certification.[30,31] Specialty categories were internal medicine, family medicine, and pediatrics (each 3 years of training); emergency medicine (3 years of training, oral examination); radiology (4 years of training, 1 year of clinical experience, oral examination); surgery/surgical specialties (each ≥5 years of training, oral examination), including surgery, urology (16 months of clinical experience), plastic surgery, orthopedic surgery (2 years of clinical experience), neurologic surgery (42 months of clinical experience), otolaryngology, colorectal surgery, thoracic surgery, and other surgical subspecialty; obstetrics/gynecology (4 years of training, 2 years of clinical experience, oral examination); and other nongeneralist specialties (each with ≥3 years of training and <2000 graduates who chose the specialty in the final study sample), including allergy and immunology, anesthesiology (oral examination), dermatology, medical genetics, neurology (oral examination), nuclear medicine, ophthalmology (oral examination), pathology, physical medicine and rehabilitation (oral examination), preventive medicine, psychiatry (oral examination), and choice of "other" specialty on the Graduation Questionnaire.

We included a dichotomous variable for first-attempt Step 1 results (pass vs fail) and a 4-category variable for first-attempt Step 2 Clinical Knowledge results (upper [range, 226-281], middle [range, 206-225], and lower [range, 170-205] tertiles of 3-digit passing scores vs all failing scores in the study sample) as predictor variables in the models. Using AAMC GME Track data, we created variables to distinguish between graduates who did or did not have a record of GME, complete specialty GME, transfer to a different specialty during GME, or take a leave of absence from GME and had or had not withdrawn or been dismissed from a GME program.

Outcome Measure

American Board of Medical Specialties records for member board certification activity for graduates in our data-

base, including active and expired certification, were provided to the AAMC by Medical Marketing Services Inc, a licensed AMA Masterfile vendor, on behalf of the investigators through a data licensing agreement with the ABMS. In accordance with these ABMS records, we created a dichotomous variable for ABMS member board certification: having a record of certification by at least 1 of the 24 member boards vs having no record of certification by any board (reference group).[30]

Statistical Analysis

We used χ^2 tests to describe associations among categorical variables and analysis of variance to describe between-group differences in continuous variables. We report descriptive statistics for each independent variable and the dependent variable, ABMS member board certification, within each specialty category. We report crude and adjusted odds ratios and 95% CIs from separate multivariable logistic regression models for each specialty category to identify independent predictors of ABMS member board certification. All tests were performed with SPSS, version 17.0.3 (SPSS Inc, Chicago, Illinois); 2-sided $P<.05$ was considered significant.

RESULTS

Of all 57 437 graduates in the 1997-2000 graduating classes, 49 898 (86.9%) answered the Graduation Questionnaire item about plans to become board certified in a specialty, 47 035 of whom responded yes to this item. Of these 47 035 individuals, 46 757 (99.4%) chose a specialty on the Graduation Questionnaire, and 46 642 (99.2%) entered GME after graduation; 2098 of these 46 642 graduates (4.5%) changed specialties during GME and were excluded. We further excluded (because of small numbers) 956 graduates with multiple/unknown race/ethnicity reported, leaving 43 478 (75.7%) graduates eligible for inclusion in the analysis. Of those eligible, we included 42 440 (97.6%) graduates with data available for all items of interest on the Graduation Questionnaire, Step l, and Step 2 Clinical Knowledge results. Exclusions because of lack of all data of interest were greater for underrepresented minorities (220/5898 [3.7%]) than for Asian/Pacific Islanders (165/7441 [2.2%]) and whites (653/30 139 [2.2%]; $P < .001$). These exclusions were greater for graduates with Step l first-attempt failing scores (80/1698 [4.7%]) than for graduates with Step l first-attempt passing scores (949/41 771 [2.3%]; $P < .001$). They were also greater for graduates with Step 2 Clinical Knowledge first-attempt failing scores (57/1675 [3.4%]) than for graduates with Step 2 Clinical Knowledge first-attempt passing scores (964/41 786 [2.3%]; $P=.004$). The proportion of eligible graduates excluded did not differ significantly between board-certified graduates (902/37 956 [2.4%]) and non–board-certified graduates (136/5522 [2.5%]; $P=.69$) or between women (432/18 303 [2.4%]) and men (606/25 175 [2.4%]; $P=.75$).

Study sample characteristics grouped by board certification status are shown in TABLE 1, TABLE 2, TABLE 3, and TABLE 4 for each specialty category. Board certification rates and mean Step l and Step 2 Clinical Knowledge scores varied among specialty categories. Graduation year, race/ethnicity, age at graduation, US Medical Licensing Examination Step l and Step 2 Clinical Knowledge results, leave of absence during GME, and withdrawal/dismissal during GME were associated with board certification in all 8 specialty categories.

Tables 1-4 show results of the adjusted logistic regression models of variables associated with board certification for each specialty category. Results of both crude and adjusted models are shown in the eTable (http://www.jama.com) In all 8 adjusted models, older graduates and graduates who had withdrawn/were dismissed from a GME program were less likely to become board certified. In 6 specialty categories (but not emergency medicine or radiology), graduates with first-attempt passing US Medical Licensing Examination Step l scores (vs first-attempt failing scores) were more likely to be board certified. In all specialty categories, graduates with first-attempt passing Step 2 Clinical Knowledge scores in the middle and upper tertiles were more likely to become board certified; in all but emergency medicine, graduates with first-attempt passing Step 2 Clinical Knowledge scores in the lowest tertile also were more likely to be board certified.

In the family medicine category, graduates with higher levels of debt were more likely to be board certified. However, in the obstetrics/gynecology category, graduates with higher levels of debt were less likely to be board certified. Compared with whites, underrepresented minorities in all specialty categories except family medicine were less likely to be board certified, as were Asians/Pacific Islanders in the surgery/surgical specialties category. Women in the obstetrics/gynecology, surgery/surgical specialties, and other nongeneralist specialties categories were less likely to be board certified.

Of the 5386 non–board-certified graduates, 3655 (67.9%) were actively licensed and had completed specialty GME, 678 (12.6%) were actively licensed but had not completed specialty GME, 628 (11.7%) were not actively licensed but had completed specialty GME, and 425 (7.9%) were not actively licensed and had not completed specialty GME.

COMMENT

Overall, 87.3% of our sample of 1997-2000 US medical school graduates were ABMS member board certified, similar to the 88% board certification rate in 2003 among of an earlier cohort of 1958-1994 graduates in selected specialties.[32] Our study adds to this literature by identifying variables associated with board certification

Table 1. Characteristics of the Sample and Adjusted Logistic Regression Models of Factors Associated With Board Certification for Internal Medicine and Pediatrics[a]

	Internal Medicine						Pediatrics					
	No. (%)						No. (%)					
Characteristics	Total (n = 9271)[b]	Not Board Certified (n = 658)[c]	Board Certified (n = 8613)[c]	*P* Value[d]	AOR (95% CI)	*P* Value	Total (n = 5384)[b]	Not Board Certified (n = 352)[c]	Board Certified (n = 5032)[c]	*P* Value[d]	AOR (95% CI)	*P* Value
Graduation year												
1997	2336 (25.2)	83 (3.6)	2253 (96.4)	<.001	NA	NA	1255 (23.3)	61 (4.9)	1194 (95.1)	<.001	NA	NA
1998	2550 (27.5)	123 (4.8)	2427 (95.2)		NA	NA	1505 (28.0)	85 (5.6)	1420 (94.4)		NA	NA
1999	2175 (23.5)	130 (6.0)	2045 (94.0)		NA	NA	1291 (24.0)	82 (6.4)	1209 (93.6)		NA	NA
2000	2210 (23.8)	322 (14.6)	1888 (85.4)		NA	NA	1333 (24.8)	124 (9.3)	1209 (90.7)		NA	NA
Sex												
Male	5499 (59.3)	377 (6.9)	5122 (93.1)	.27	1 [Ref]	.46	1816 (33.7)	109 (6.0)	1707 (94.0)	.26	1 [Ref]	.23
Female	3772 (40.7)	281 (7.4)	3491 (92.6)		0.94 (0.79-1.11)		3568 (66.3)	243 (6.8)	3325 (93.2)		0.85 (0.66-1.10)	
Race/ethnicity												
White	5992 (64.6)	346 (5.8)	5646 (94.2)	<.001	1 [Ref]		3764 (69.9)	166 (4.4)	3598 (95.6)	<.001	1 [Ref]	
Underrepresented minority	1111 (12.0)	165 (14.9)	946 (85.1)		0.69 (0.55-0.87)	.001	798 (14.8)	132 (16.5)	666 (83.5)		0.44 (0.33-0.58)	<.001
Asian/Pacific Islander	2168 (23.4)	147 (6.8)	2021 (93.2)		0.93 (0.75-1.15)	.50	822 (15.3)	54 (6.6)	768 (93.4)		0.72 (0.51-1.00)	.05
Age at graduation, y												
<28	6435 (69.4)	378 (5.9)	6057 (94.1)	<.001	1 [Ref]		4064 (75.5)	206 (5.1)	3858 (94.9)	<.001	1 [Ref]	
≥28	2836 (30.6)	280 (9.9)	2556 (90.1)		0.66 (0.56-0.79)	<.001	1320 (24.5)	146 (11.1)	1174 (88.9)		0.45 (0.35-0.58)	<.001
First-attempt USMLE Step 1												
Fail	307 (3.3)	89 (29.0)	218 (71.0)	<.001	1 [Ref]		239 (4.4)	80 (33.5)	159 (66.5)	<.001	1 [Ref]	
Pass	8964 (96.7)	569 (6.3)	8395 (93.7)		2.00 (1.46-2.73)	<.001	5145 (95.6)	272 (5.3)	4873 (94.7)		2.96 (2.07-4.22)	<.001
Step 1 score, mean (95% CI)	215.8 (215.4-216.2)	204.5 (202.7-206.4)	216.7 (216.3-217.1)	<.001	NA	NA	211.0 (210.4-211.5)	194.9 (192.4-197.4)	212.1 (211.6-212.6)	<.001	NA	NA
First-attempt USMLE Step 2CK												
Fail	307 (3.3)	98 (31.9)	209 (68.1)	<.001	1 [Ref]		184 (3.4)	77 (41.8)	107 (58.2)	<.001	1 [Ref]	
Low tertile pass	2678 (28.9)	294 (11.0)	2384 (89.0)		2.55 (1.88-3.44)	<.001	1872 (34.8)	172 (9.2)	1700 (90.8)		4.64 (3.22-6.69)	<.001
Middle tertile pass	3031 (32.7)	133 (4.4)	2898 (95.6)		5.98 (4.24-8.42)	<.001	1858 (34.5)	59 (3.2)	1799 (96.8)		10.98 (7.05-17.07)	<.001
High tertile pass	3255 (35.1)	133 (4.1)	3122 (95.9)		6.10 (4.30-8.65)	<.001	1470 (27.3)	44 (3.0)	1426 (97.0)		10.52 (6.53-16.94)	<.001
Step 2CK score, mean (95% CI)	215.1 (214.6-215.6)	199.6 (197.4-201.7)	216.3 (215.8-216.8)	<.001	NA	NA	211.2 (210.6-211.8)	192.3 (189.6-195.0)	212.5 (211.9-213.1)	<.001	NA	NA
Debt at graduation, $[f]				.02	0.94 (0.87-1.00)	.06				.001	0.95 (0.86-1.05)	.31
No debt	1691 (18.2)	97 (5.7)	1594 (94.3)		NA	NA	828 (15.4)	50 (6.0)	778 (94.0)		NA	NA
1-49 999	1616 (17.4)	108 (6.7)	1508 (93.3)		NA	NA	946 (17.6)	57 (6.0)	889 (94.0)		NA	NA
50 000-99 999	3196 (34.5)	221 (6.9)	2975 (93.1)		NA	NA	1930 (35.8)	109 (5.6)	1821 (94.4)		NA	NA
100 000-149 999	1914 (20.6)	158 (8.3)	1756 (91.7)		NA	NA	1167 (21.7)	81 (6.9)	1086 (93.1)		NA	NA
≥150 000	854 (9.2)	74 (8.7)	780 (91.3)		NA	NA	513 (9.5)	55 (10.7)	458 (89.3)		NA	NA
Leave of absence during GME												
No	9249 (99.8)	652 (7.0)	8597 (93.0)	.003[e]	1 [Ref]		5374 (99.8)	349 (6.5)	5025 (93.5)	.02[e]	1 [Ref]	
Yes	22 (0.2)	6 (27.3)	16 (72.7)		0.34 (0.11-1.01)	.05	10 (0.2)	3 (3.0)	7 (70.0)		0.16 (0.03-0.76)	.02
Withdrew/dismissed from GME												
No	9176 (99.0)	631 (6.9)	8545 (93.1)	<.001[e]	1 [Ref]		5292 (98.3)	330 (6.2)	4962 (93.8)	<.001[e]	1 [Ref]	
Yes	95 (1.0)	27 (28.4)	68 (0.8)		0.22 (0.14-0.36)	<.001	92 (1.7)	22 (23.9)	70 (76.1)		0.16 (0.09-0.27)	<.001

Abbreviations: AOR, adjusted odds ratio; 2CK, Step 2 Clinical Knowledge; GME, graduate medical education; NA, not analyzed; Ref, reference category; USMLE, United States Medical Licensing Examination.

[a] Adjusted logistic regression models included all variables shown except graduation year and mean Step 1 and Step 2CK scores (variables for unanalyzed cells were not included in the multivariable regression models). Because each specialty category at graduation was examined separately, the number of postgraduate training years required for board certification in a given specialty category was controlled in the separate models. Categorical Step 1 and Step 2CK variables rather than the 3-digit scores were included in the models. Debt at graduation was analyzed as a continuous variable. Hosmer-Lemeshow goodness-of-fit statistics for all models were acceptable (each $P > .05$).

[b] Percentage of column total.

[c] Percentage of row total for each characteristic (ie, number not board certified [or number board certified]/row total number) for each specialty category.

[d] *P* values are from 2-sided χ^2 tests for categorical variables and from 1-way analysis of variance for mean Step 1 and Step 2CK scores.

[e] *P* values are 2-sided Fisher exact test.

[f] AOR < 1.00 indicates lower likelihood of board certification with each increasing unit ($50 000) of total debt at graduation; AOR > 1.00 indicates greater likelihood of board certification with each increasing unit ($50 000) of total debt at graduation.

achievement among a national sample of US medical school graduates, with a composition reflective of the sex and racial/ethnic diversity of more contemporary US medical school graduates. Furthermore, to our knowledge the demographic and academic performance variables that we found to be associated with ABMS member board certification have not previously been examined among US medical school graduates in multivariable models. The study analyzed predictors of board certification separately for 8 specialty category groups. We identified differ-

Table 2. Characteristics of the Sample and Adjusted Logistic Regression Models of Factors Associated With Board Certification for Family Medicine and Emergency Medicine[a]

	Family Medicine						Emergency Medicine					
	No. (%)						No. (%)					
Characteristics	Total (n = 6498)[b]	Not Board Certified (n = 303)[c]	Board Certified (n = 6195)[c]	*P* Value[d]	AOR (95% CI)	*P* Value	Total (n = 2890)[b]	Not Board Certified (n = 431)[c]	Board Certified (n = 2459)[c]	*P* Value[d]	AOR (95% CI)	*P* Value
Graduation year												
1997	1795 (27.7)	52 (2.9)	1745 (97.1)	<.001	NA	NA	644 (22.3)	33 (5.1)	611 (94.9)	<.001	NA	NA
1998	1844 (28.4)	78 (4.2)	1766 (95.8)		NA	NA	697 (24.1)	54 (7.7)	643 (92.3)		NA	NA
1999	1411 (21.7)	65 (4.6)	1346 (95.4)		NA	NA	718 (24.8)	118 (16.4)	600 (83.6)		NA	NA
2000	1446 (22.3)	108 (7.5)	1338 (92.5)		NA	NA	831 (28.8)	226 (27.2)	605 (72.8)		NA	NA
Sex												
Male	3408 (52.4)	152 (4.5)	3256 (95.5)	.42	1 [Ref]	.18	2107 (72.9)	316 (15.0)	1791 (85.0)	.84	1 [Ref]	.69
Female	3090 (47.6)	151 (4.9)	2939 (95.1)		0.84 (0.66-1.08)		783 (27.1)	115 (14.7)	668 (85.3)		1.05 (0.83-1.33)	
Race/ethnicity												
White	4899 (75.4)	180 (3.7)	4719 (96.3)	<.001	1 [Ref]		2126 (73.6)	301 (14.2)	1825 (85.8)	.001	1 [Ref]	
Underrepresented minority	944 (14.5)	86 (9.1)	858 (90.9)		0.75 (0.55-1.03)	.08	384 (13.3)	82 (21.4)	302 (78.6)		0.74 (0.55-0.99)	.04
Asian/Pacific Islander	655 (10.1)	37 (5.6)	618 (94.4)		0.80 (0.54-1.18)	.261	380 (13.1)	48 (12.6)	332 (87.4)		1.13 (0.81-1.58)	.46
Age at graduation, y												
<28	4036 (62.1)	144 (3.6)	3892 (96.4)	<.001	1 [Ref]	<.001	1799 (62.2)	239 (13.3)	1560 (86.7)	.002	1 [Ref]	.03
≥28	2462 (37.9)	159 (6.5)	2303 (93.5)		0.60 (0.47-0.77)		1091 (37.8)	192 (17.6)	899 (82.4)		0.79 (0.64-0.98)	
First-attempt USMLE Step 1												
Fail	422 (6.5)	68 (16.1)	354 (83.9)	<.001	1 [Ref]	<.001	77 (2.7)	22 (28.6)	55 (71.4)	.002[e]	1 [Ref]	.18
Pass	6076 (93.5)	235 (3.9)	5841 (96.1)		2.05 (1.44-2.93)		2813 (97.3)	409 (14.5)	2404 (85.5)		1.47 (0.84-2.56)	
Step 1 score, mean (95% CI)	206.3 (205.8-206.8)	194.3 (191.8-196.9)	206.9 (206.4-207.4)	<.001	NA	NA	215.2 (214.5-215.9)	211.8 (209.9-213.8)	215.8 (215.1-216.5)	<.001	NA	NA
First-attempt USMLE Step 2CK												
Fail	343 (5.3)	65 (19.0)	278 (81.0)	<.001	1 [Ref]		87 (3.0)	23 (26.4)	64 (73.6)	<.001	1 [Ref]	
Low tertile pass	2738 (42.1)	154 (5.6)	2584 (94.4)		2.73 (1.90-3.90)	<.001	918 (31.8)	173 (18.8)	745 (81.2)		1.28 (0.75-2.19)	.36
Middle tertile pass	2112 (32.5)	57 (2.7)	2055 (97.3)		4.84 (3.09-7.58)	<.001	1018 (35.2)	126 (12.4)	892 (87.6)		1.97 (1.13-3.45)	.02
High tertile pass	1305 (20.1)	27 (2.1)	1278 (97.9)		6.52 (3.79-11.22)	<.001	867 (30.0)	109 (12.6)	758 (87.4)		1.82 (1.03-3.20)	.04
Step 2CK score, mean (95% CI)	206.1 (205.5-206.6)	189.9 (187.0-192.8)	206.9 (206.3-207.4)	<.001	NA	NA	213.2 (212.4-214.0)	208.0 (205.7-210.2)	214.1 (213.3-214.9)	<.001	NA	NA
Debt at graduation, $[f]				.001	1.13 (1.01-1.26)	.03				.10	0.95 (0.87-1.04)	.23
No debt	714 (11.0)	53 (7.4)	661 (92.6)		NA	NA	340 (11.8)	53 (15.6)	287 (84.4)		NA	NA
1-49 999	1197 (18.4)	53 (4.4)	1144 (95.6)		NA	NA	453 (15.7)	53 (11.7)	400 (88.3)		NA	NA
50 000-99 999	2578 (39.7)	95 (3.7)	2483 (96.3)		NA	NA	965 (33.4)	135 (14.0)	830 (86.0)		NA	NA
100 000-149 999	1474 (22.7)	76 (5.2)	1398 (94.8)		NA	NA	716 (24.8)	122 (17.0)	594 (83.0)		NA	NA
≥150 000	535 (8.2)	26 (4.9)	509 (95.1)		NA	NA	416 (14.4)	68 (16.3)	348 (83.7)		NA	NA
Leave of absence during GME												
No	6494 (99.9)	300 (4.6)	6194 (95.4)	<.001[e]	1 [Ref]	<.001	2884 (99.8)	427 (14.8)	2457 (85.2)	.006[e]	1 [Ref]	.004
Yes	4 (0.1)	3 (75.0)	1 (25.0)		0.01 (0.001-0.10)		6 (0.2)	4 (66.7)	2 (33.3)		0.08 (0.01-0.44)	
Withdrew/dismissed from GME												
No	6452 (99.3)	278 (4.3)	6174 (95.7)	<.001[e]	1 [Ref]	<.001	2853 (98.7)	418 (14.7)	2435 (85.3)	.002[e]	1 [Ref]	.006
Yes	46 (0.7)	25 (54.3)	21 (45.7)		0.04 (0.02-0.08)		37 (1.3)	13 (35.1)	24 (64.9)		0.37 (0.19-0.75)	

Abbreviations: AOR, adjusted odds ratio; 2CK, Step 2 Clinical Knowledge; GME, graduate medical education; NA, not analyzed; Ref, reference category; USMLE, United States Medical Licensing Examination.
[a-f]See footnotes to Table 1.

ences across categories, which were expected, given differences in training duration, clinical experience, and oral examination requirements for board certification, as well as differences in written certifying examination first-attempt pass rates.[31,33-37]

Each of 4 demographic variables was associated with board certification. Older graduates in each specialty category were less likely to be board certified, extending observations of 2 single-specialty studies.[35,38] Older examinees were more likely to fail the internal medicine certifying examina-

Table 3. Characteristics of the Sample and Adjusted Logistic Regression Models of Factors Associated With Board Certification for Radiology and Obstetrics/Gynecology[a]

	Radiology						Obstetrics/Gynecology					
	No. (%)						No. (%)					
Characteristics	Total (n = 2114)[b]	Not Board Certified (n = 120)[c]	Board Certified (n = 1994)[c]	*P* Value[d]	AOR (95% CI)	*P* Value	Total (n = 3057)[b]	Not Board Certified (n = 882)[c]	Board Certified (n = 2175)[c]	*P* Value[d]	AOR (95% CI)	*P* Value
Graduation year												
1997	339 (16.0)	12 (3.5)	327 (96.5)		NA	NA	804 (26.3)	98 (12.2)	706 (87.8)		NA	NA
1998	477 (22.6)	26 (55.5)	451 (94.5)	.26	NA	NA	791 (25.9)	125 (15.8)	666 (84.2)	<.001	NA	NA
1999	568 (26.9)	35 (6.2)	533 (93.8)		NA	NA	737 (24.1)	187 (25.4)	550 (74.6)		NA	NA
2000	730 (34.5)	47 (6.4)	683 (93.6)		NA	NA	725 (23.7)	472 (65.1)	253 (34.9)		NA	NA
Sex												
Male	1616 (76.4)	88 (5.4)	1528 (94.6)		1 [Ref]		808 (26.4)	201 (24.9)	607 (75.1)		1 [Ref]	
Female	498 (23.6)	32 (6.4)	466 (93.6)	.41	0.83 (0.52-1.30)	.42	2249 (73.6)	681 (30.3)	1568 (69.7)	.004	0.70 (0.57-0.84)	<.001
Race/ethnicity												
White	1380 (65.3)	67 (4.9)	1313 (95.1)		1 [Ref]		1999 (65.4)	511 (25.6)	1488 (74.4)		1 [Ref]	
Underrepresented minority	217 (10.3)	29 (13.4)	188 (86.6)	<.001	0.52 (0.31-0.87)	.01	654 (21.4)	267 (40.8)	387 (59.2)	<.001	0.64 (0.52-0.79)	<.001
Asian/Pacific Islander	517 (24.5)	24 (4.6)	493 (95.4)		1.09 (0.65-1.82)	.74	404 (13.2)	104 (25.7)	300 (74.3)		0.99 (0.76-1.28)	.93
Age at graduation, y												
<28	1430 (67.6)	54 (3.8)	1376 (96.2)		1 [Ref]		2116 (69.2)	539 (25.5)	1577 (74.5)		1 [Ref]	
≥28	684 (32.4)	66 (9.6)	618 (90.4)	<.001	0.42 (0.28-0.62)	<.001	941 (30.8)	343 (36.5)	598 (63.5)	<.001	0.63 (0.53-0.74)	<.001
First-attempt USMLE Step 1												
Fail	50 (2.4)	11 (22.0)	39 (78.0)		1 [Ref]		138 (4.5)	78 (56.5)	60 (43.5)		1 [Ref]	
Pass	2064 (97.6)	109 (5.3)	1955 (94.7)	<.001[e]	1.35 (0.59-3.09)	.48	2919 (95.5)	804 (27.5)	2115 (72.5)	<.001	1.88 (1.27-2.79)	.002
Step 1 score, mean (95% CI)	216.5 (215.7-217.3)	202.8 (198.9-206.6)	217.3 (216.5-218.1)	<.001	NA	NA	209.9 (209.3-210.6)	207.6 (206.2-209.0)	210.9 (210.1-211.6)	<.001	NA	NA
First-attempt USMLE Step 2CK												
Fail	77 (3.6)	20 (26.0)	57 (74.9)		1 [Ref]		103 (3.4)	68 (66.0)	35 (34.0)		1 [Ref]	
Low tertile pass	754 (35.7)	68 (9.0)	686 (91.0)		3.17 (1.68-6.00)	<.001	1053 (34.4)	334 (31.7)	719 (68.3)		3.32 (2.11-5.24)	<.001
Middle tertile pass	716 (33.9)	21 (2.9)	695 (97.1)	<.001	8.23 (3.89-17.43)	<.001	1086 (35.5)	280 (25.8)	806 (74.2)	<.001	3.72 (2.32-5.97)	<.001
High tertile pass	567 (26.8)	11 (1.9)	556 (98.1)		13.19 (5.55-31.32)	<.001	815 (26.7)	200 (24.5)	615 (75.5)		3.79 (2.34-6.16)	<.001
Step 2CK score, mean (95% CI)	210.7 (209.8-211.7)	192.4 (188.0-196.9)	211.8 (210.8-212.8)	<.001	NA	NA	211.0 (210.2-211.8)	206.9 (205.3-208.6)	212.6 (211.8-213.5)	<.001	NA	NA
Debt at graduation, $[f]				.003	0.90 (0.77-1.06)	.23				<.001	0.89 (0.83-0.96)	.001
No debt	391 (18.5)	16 (4.1)	375 (95.9)		NA	NA	414 (13.5)	106 (25.6)	308 (74.4)		NA	NA
1-49 999	339 (16.0)	12 (3.5)	327 (96.5)		NA	NA	532 (17.4)	139 (26.1)	393 (73.9)		NA	NA
50 000-99 999	690 (32.6)	44 (6.4)	646 (93.6)		NA	NA	1045 (34.2)	275 (26.3)	770 (73.7)		NA	NA
100 000-149 999	458 (21.7)	23 (5.0)	435 (95.0)		NA	NA	729 (23.8)	238 (32.6)	491 (67.4)		NA	NA
≥150 000	236 (11.2)	25 (10.6)	211 (89.4)		NA	NA	337 (11.0)	124 (36.8)	213 (63.2)		NA	NA
Leave of absence during GME												
No	2112 (99.9)	119 (5.6)	1993 (94.4)		1 [Ref]		3049 (99.7)	876 (28.7)	2173 (71.3)		1 [Ref]	
Yes	2 (0.1)	1 (50.0)	1 (50.0)	.11[e]	0.08 (0.004-1.60)	.098	8 (0.3)	6 (75.0)	2 (25.0)	.009[e]	0.18 (0.03-0.94)	.04
Withdrew/dismissed from GME												
No	2079 (98.3)	107 (5.1)	1972 (94.9)		1 [Ref]		2992 (97.9)	848 (28.3)	2144 (71.7)		1 [Ref]	
Yes	35 (1.7)	13 (37.1)	22 (62.9)	<.001[e]	0.13 (0.06-0.28)	<.001	65 (2.1)	34 (52.3)	31 (47.7)	<.001[e]	0.40 (0.24-0.66)	<.001

Abbreviations: AOR, adjusted odds ratio; 2CK, Step 2 Clinical Knowledge; GME, graduate medical education; NA, not analyzed; Ref, reference category; USMLE, United States Medical Licensing Examination.
[a-f]See footnotes to Table 1.

tion,[35] and residents who initially passed both qualifying and certifying American Board of Surgery examinations were younger than residents who initially failed.[38] Our findings suggest that older graduates may experience greater difficulties, regardless of specialty choice, in timely advancement along the GME continuum toward board certification.

A 1997 study of US medical school graduates reported lower overall board-

Table 4. Characteristics of the Sample and Adjusted Logistic Regression Models of Factors Associated With Board Certification for Surgery and Other Specialties[a]

	Surgery/Surgical Specialties						Other Nongeneralist Specialties					
	No. (%)						No. (%)					
Characteristics	Total (n = 6804)[b]	Not Board Certified (n = 1506)[c]	Board Certified (n = 5298)[c]	*P* Value[d]	AOR (95% CI)	*P* Value	Total (n = 6422)[b]	Not Board Certified (n = 1134)[c]	Board Certified (n = 5288)[c]	*P* Value[d]	AOR (95% CI)	*P* Value
Graduation year												
1997	1618 (23.8)	239 (14.8)	1379 (85.2)	<.001	NA	NA	1150 (17.9)	162 (14.1)	988 (85.9)	<.001	NA	NA
1998	1687 (24.8)	257 (15.2)	1430 (84.8)		NA	NA	1433 (22.3)	304 (21.2)	1129 (78.8)		NA	NA
1999	1681 (24.7)	368 (21.9)	1313 (78.1)		NA	NA	1744 (27.2)	288 (16.5)	1456 (83.5)		NA	NA
2000	1818 (26.7)	642 (35.3)	1176 (64.7)		NA	NA	2095 (32.6)	380 (18.1)	1715 (81.9)		NA	NA
Sex												
Male	5513 (81.0)	1156 (21.0)	4357 (79.0)		1 [Ref]		3802 (59.2)	607 (16.0)	3195 (84.0)		1 [Ref]	
Female	1291 (19.0)	350 (27.1)	941 (72.9)	<.001	0.75 (0.65-0.87)	<.001	2620 (40.8)	527 (20.1)	2093 (79.9)	<.001	0.73 (0.63-0.83)	<.001
Race/ethnicity												
White	4866 (71.5)	962 (19.8)	3904 (80.2)		1 [Ref]		4460 (69.4)	729 (16.3)	3731 (83.7)		1 [Ref]	
Underrepresented minority	794 (11.7)	259 (32.6)	535 (67.4)	<.001	0.66 (0.56-0.79)	<.001	776 (12.1)	221 (28.5)	555 (71.5)	<.001	0.79 (0.64-0.96)	.02
Asian/Pacific Islander	1144 (16.8)	285 (24.9)	859 (75.1)		0.75 (0.64-0.88)	<.001	1186 (18.5)	184 (15.5)	1002 (84.5)		1.14 (0.94-1.37)	.19
Age at graduation, y												
<28	4876 (71.7)	988 (20.3)	3888 (79.7)		1 [Ref]		4019 (62.6)	620 (15.4)	3399 (84.6)		1 [Ref]	
≥28	1928 (28.3)	518 (26.9)	1410 (73.1)	<.001	0.73 (0.64-0.83)	<.001	2403 (37.4)	514 (21.4)	1889 (78.6)	<.001	0.75 (0.65-0.86)	<.001
First-attempt USMLE Step 1												
Fail	100 (1.5)	52 (52.0)	48 (48.0)		1 [Ref]		285 (4.4)	126 (44.2)	159 (55.8)		1 [Ref]	
Pass	6704 (98.5)	1454 (21.7)	5250 (78.3)	<.001	2.13 (1.38-3.28)	.001	6137 (95.6)	1008 (16.4)	5129 (83.6)	<.001	1.82 (1.37-2.42)	<.001
Step 1 score, mean (95% CI)	220.7 (220.2-221.1)	218.1 (217.1-219.2)	221.4 (220.9-221.8)	<.001	NA	NA	213.3 (212.8-213.8)	205.2 (203.9-206.6)	215.0 (214.5-215.5)	<.001	NA	NA
First-attempt USMLE Step 2CK												
Fail	152 (2.2)	79 (52.0)	73 (48.0)		1 [Ref]		365 (5.7)	161 (44.1)	204 (55.9)		1 [Ref]	
Low tertile pass	1868 (27.5)	500 (26.8)	1368 (73.2)		2.12 (1.48-3.04)	<.001	2424 (37.7)	516 (21.3)	1908 (78.7)		2.17 (1.69-2.81)	<.001
Middle tertile pass	2473 (36.3)	501 (20.3)	1972 (79.7)	<.001	2.70 (1.88-3.89)	<.001	2069 (32.2)	278 (13.4)	1791 (86.6)	<.001	3.59 (2.72-4.74)	<.001
High tertile pass	2311 (34.0)	426 (18.4)	1885 (81.6)		2.90 (2.01-4.20)	<.001	1564 (24.4)	179 (11.4)	1385 (88.6)		4.26 (3.17-5.74)	<.001
Step 2CK score, mean (95% CI)	215.6 (215.1-216.1)	210.8 (209.6-212.0)	217.0 (216.4-217.5)	<.001	NA	NA	208.6 (208.0-209.2)	198.7 (197.2-200.2)	210.7 (210.1-211.3)	<.001	NA	NA
Debt at graduation, $[f]				.26	1.00 (0.95-1.05)	.990				.009	0.99 (0.94-1.05)	.73
No debt	1249 (18.4)	267 (21.4)	982 (78.6)		NA	NA	1234 (19.2)	206 (16.7)	1028 (83.3)		NA	NA
1-49 999	1204 (17.7)	276 (22.9)	928 (77.1)		NA	NA	1060 (16.5)	190 (17.9)	870 (82.1)		NA	NA
50 000-99 999	2139 (31.4)	447 (20.9)	1692 (79.1)		NA	NA	2053 (32.0)	328 (16.0)	1725 (84.0)		NA	NA
100 000-149 999	1504 (22.1)	343 (22.8)	1161 (77.2)		NA	NA	1398 (21.8)	289 (20.7)	1109 (79.3)		NA	NA
≥150 000	708 (10.4)	173 (24.4)	535 (75.6)		NA	NA	677 (10.5)	121 (17.9)	556 (82.1)		NA	NA
Leave of absence during GME												
No	6783 (99.7)	1494 (22.0)	5289 (78.0)		1 [Ref]		6398 (99.6)	1114 (17.4)	5284 (82.6)		1 [Ref]	
Yes	21 (0.3)	12 (57.1)	9 (42.9)	.001[e]	0.28 (0.11-0.68)	.005	24 (0.4)	20 (83.3)	4 (16.7)	<.001[e]	0.05 (0.02-0.16)	<.001
Withdrew/dismissed from GME												
No	6545 (96.2)	1383 (21.1)	5162 (78.9)		1 [Ref]		6242 (97.2)	1040 (16.7)	5202 (83.3)		1 [Ref]	
Yes	259 (3.8)	123 (47.5)	136 (52.5)	<.001[e]	0.35 (0.27-0.45)	<.001	180 (2.8)	94 (52.2)	86 (47.8)	<.001[e]	0.21 (0.16-0.29)	<.001

Abbreviations: AOR, adjusted odds ratio; 2CK, Step 2 Clinical Knowledge; GME, graduate medical education; NA, not analyzed; Ref, reference category; USMLE, United States Medical Licensing Examination.

[a-f] See footnotes to Table 1. Other nongeneralist specialties include the following choices on the Graduation Questionnaire (GQ): allergy and immunology, anesthesiology, dermatology, medical genetics, neurology, nuclear medicine, ophthalmology, pathology, physical medicine and rehabilitation, preventive medicine, psychiatry, and choice of "other" specialty.

certification rates among women than men (67.0% vs 75.9%).[39] We did not observe differences in the likelihood of board certification between the sexes in 5 of 8 specialty categories examined, suggesting that gender gaps in board certification may be narrowing among recent US medical school graduates in many specialties.[39,40] We observed the gender gap in board certification rates among graduates choosing obstetrics/gynecology, which is currently the specialty with the largest proportion of physicians in training who are women (79%) among all specialties surveyed in the GME Census.[24] A single-institutional study of 1964-1994 US medical school graduates practicing in obstetrics/gynecology in 2003 reported that sex was not a predictor of board certification.[27] This finding suggests that, with longer follow-up of our cohort, the gender gap in board certification that we observed in the obstetrics/gynecology specialty category might diminish.

In every specialty category except family medicine, underrepresented minorities were less likely than whites to be board certified, as were Asian/Pacific Islander graduates in the surgery/surgical specialties category. These associations were observed in models that controlled for Step l and Step 2 Clinical Knowledge results and total debt, among other factors, raising concerns about ongoing efforts by US medical schools to increase the racial/ethnic diversity of the physician workforce, an issue of national concern.[41,42] Because we observed these differences in a sample that included only graduates who reported specialty board certification intentions at graduation, there may be factors after graduation that disproportionately and negatively affect nonwhite—particularly underrepresented minority—medical school graduates' timely advancement along the postgraduation medical education continuum to board certification. Further research is warranted to identify factors after graduation that are associated with board certification and amenable to intervention so that these observed disparities in board certification can be eliminated.

Although there were differences in board certification rates on the basis of total debt among graduates in almost all specialty categories (Tables 1-4), there was not a consistent relationship between higher debt and board certification among specialty categories. These mixed findings suggest that studies assessing possible relationships between debt and medical school graduates' career paths should control for specialty choices.

Both first-attempt Step 1 and Step 2 Clinical Knowledge passing scores were associated with greater likelihood of board certification, extending observations of earlier studies. Previous studies have been limited by inclusion of graduates in only 1 or a few specialties or graduates from a single institution, and some earlier studies pertained to performance on National Board of Medical Examiners Parts I and II rather than US Medical Licensing Examination Step l and Step 2 Clinical Knowledge.[26,34] Recent studies have also been limited to examination of relationships between US Medical Licensing Examination Step scores and first-attempt performance on board-certifying examinations,[38] not achievement of board certification itself. Such studies have reported differences in first-attempt results on the American Board of Surgery,[38] the American Board of Orthopaedic Surgery,[43] and the American Board of Pediatrics[44] written examinations in relation to examinees' first-attempt Step l and Step 2 Clinical Knowledge scores.

Our study differs from these studies in that we analyzed Step l and Step 2 Clinical Knowledge results as categorical rather than continuous variables across several specialty categories, and we analyzed scores for associations with board certification, rather than certifying-examination scores. Nonetheless, we similarly demonstrated positive relationships between licensing examination results and board certification. Our findings provide support for program directors' use of first-attempt licensing examination results among criteria for evaluating applicants in a range of specialties.[45]

We identified 2 GME variables associated with a lower likelihood of board certification. Withdrawal/dismissal from a program during GME was associated with a markedly lower likelihood of board certification among graduates in all specialty categories, raising the possibility that, as a group, graduates who withdraw or are dismissed during GME may represent a particularly poorly performing group of graduates. We did not observe similar relationships across all specialty categories for graduates who took a leave of absence during GME, possibly because of the small number of graduates who took leave and their reasons for doing so (for which we lack information).

Most non–board-certified graduates in our study were actively licensed, indicating that they had satisfactorily completed at least 1 year of GME and ultimately passed US Medical Licensing Examination Step l, Step 2 Clinical Knowledge, and Step 3, all prerequisites for permanent state medical licensure,[46] and many had completed specialty GME. However, we lacked information to determine which non–board-certified graduates in our sample might or might not have fulfilled all requirements to apply for ABMS member board certification by any member board. Indeed, this determination resides exclusively with member boards. Not every graduate who has completed a program of specialty GME of a specific duration has necessarily fulfilled requirements regarding the nature and scope of specific training experiences, and some ABMS member boards accept training credit for non–Accreditation Council for Graduate Medical Education–accredited residency training.[30,31] Moreover, because ABMS member board certification is not required for physicians, lack of certification might reflect a physician's choice, depending on the physician's professional activi-

ties, not to proceed with the specialty board certification process even though the physician may have fulfilled all requirements to do so.

Strengths of the study included the use of both active and inactive ABMS records of board certification data rather than self-reported board certification data or data pertaining only to current board certification status. Another strength was the inclusion of a large national cohort of graduates with complete data for factors along the full extent of the medical education continuum.

Limitations include that, although the study used data about a nationally representative cohort of US medical school graduates, the observational design precludes making causal inferences from the findings. In addition, lack of board certification within the study's duration does not necessarily mean that a graduate will never become board certified; longer follow-up might show that some graduates become board certified, which may be especially true among graduates in those specialty categories with relatively lengthier GME requirements that also mandate clinical practice and oral examination requirements for board certification, such as obstetrics/gynecology. These results cannot be generalized to other groups of medical school graduates, such as graduates of osteopathic medical schools or international medical school graduates. Nevertheless, our findings can inform an understanding of factors contributing to US medical school graduates' advancement along the medical education continuum to board certification, an outcome of interest for medical school graduates, their patients, and the relevant professional organizations involved in undergraduate medical education, GME, and board certification.

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ments" containing steroids, and under the direction of the FDA, Bodybuilding.com subsequently recalled the supplements from the marketplace.[3] As part of their initial investigation, FDA officials had purchased 31 supplements from Bodybuilding.com, and 26 (84%) had contained at least 1 controlled substance.[4] Although the entire supplement industry cannot be held accountable for the spiked products of an online "nutrition" site, a question does arise as to whether such problems can be prevented in the future. Unless DSHEA is reformed, I suspect companies that seek only to maximize profit will continue to take their chances in the marketplace, betting that the FDA and other federal agencies will not target their products.

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CORRECTIONS

Author Name Correction: In the Original Contribution entitled "Association of Race and Sites of Care With Pressure Ulcers in High-Risk Nursing Home Residents," published in the July 13, 2011, issue of *JAMA* (2011;306[2]:179-186), the fourth author is Helena Temkin-Greener, PhD. The article has been corrected online.

Wording Errors: In the Commentary entitled "The Older Smoker," published in the August 24/31, 2011, issue of *JAMA* (2011;306[8]:876-877), 2 wording errors appeared in the third paragraph (heading "Health Care Coverage"). In the second sentence, the Medicare section should be (Part B). In the next sentence, the text should clarify that Medicaid does not currently cover pharmacological treatments for smoking cessation "across all states." The article has been corrected online.

Variable Correction: In the Original Contribution titled "Factors Associated With American Board of Medical Specialties Member Board Certification Among US Medical School Graduates," published in the September 7, 2011, issue of *JAMA* (2011;306[9]:961-970), the predictor variables in the "Methods" should have listed graduates' age at graduation as <28 vs ≥ 28 years. This article has been corrected online.

> The world is a looking glass, and gives back to every man the reflection of his own face. Frown at it, and it will in turn look sourly upon you; laugh at it and with it, and it is a jolly kind companion.
>
> —William Makepeace Thackeray (1811-1863)