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Community College Pathways: Improving the U.S. Physician Workforce Pipeline

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Abstract

Purpose

To examine the association between participation in a community college (CC) pathway, medical school admission, and intentions to practice in underserved communities or work with minority populations.

Method

The authors performed cross-sectional analyses of the 2012 Association of American Medical Colleges matriculant and applicant files and the Matriculating Student Questionnaire to assess associations between student characteristics and participation in a CC pathway. They used logistic regression to estimate the association

among CC pathway and acceptance to medical school, intention to practice in underserved areas, or intention to work with minority populations.

Results

There were 40,491 applicants and 17,518 matriculants to U.S. MD-granting schools; about one-third used a CC. A higher proportion of underrepresented minority (URM) matriculants used CC pathways compared with whites. Applicants who attended a CC after high school and before a four-year university (First-CC) had lower odds of acceptance into medical school (adjusted odds ratio [AOR] = 0.68; 95% CI 0.61–0.75; $P < .05$). Compared with medical students

who never attended a CC, First-CC matriculants were more likely to have parents without a college education (304/895 [34%] versus 1,683/12,598 [13%], $P < .001$) and higher odds of intentions to practice in underserved communities (AOR = 1.26; 95% CI 1.04–1.53; $P < .05$), after adjusting for covariates.

Conclusions

There is both high representation of URM students and higher prevalence of intention to work with underserved communities among CC pathway participants. These findings may be of interest to those seeking to enhance diversity in the physician workforce.

Editor's Note : A Commentary on this article by A. Saguil and A.L. Kellerman appears on pages 1589–1592.

Diversity in the physician workforce increases health care access for underserved populations, improves culturally and linguistically appropriate care, and better positions the workforce to serve the needs of a diverse population.^{1–9} How to achieve that diversity, however, is not well understood. To our knowledge, no prior research has clarified how or if the undergraduate pathway contributes to a diverse physician workforce that is interested in serving underserved communities. Furthermore, we are not aware of any studies that have explored the community college (CC) as a pathway to

medical school. Because CCs (two-year postsecondary educational institutions) serve as a principal higher education attainment pathway for many low-income and underrepresented minority (URM) students,¹⁰ we chose to investigate the CC pathways to medical school in this study.

In 2010, approximately eight million or 44% of all the undergraduate students in the United States were enrolled at one of the 1,600 CCs throughout the country.¹¹ The percentage of Latinos attending CCs has nearly doubled since 1992,¹² and the majority of CC students come from low-income families.¹³ CC enrollment in 2010 was as follows: 57% women, 52% white, 17% Latino, 15% black, 5% Asian, and 11% other race or not reported.¹¹ These data indicate that CC students potentially represent the type of student being targeted by national efforts to encourage URM students to pursue careers in medicine. However, achieving diversity in our future physician workforce is challenged by rising tuition costs that have outpaced family income growth. Although numerous factors influence URM interest in medicine, financial barriers can considerably widen the privilege gap, resulting in a socially stratified higher education system.¹⁴

In the United States, the majority of medical students have parents with graduate levels of education and incomes in the top quintile of all American families.^{15,16} The median student-reported parental income among matriculating medical students in 2012 was \$115,000.¹⁷ Although cost is a strong deterrent for potential applicants with lower parental income, other determinants, such as disparities in educational attainment and academic preparedness, may explain some of the demographic trends among medical school applicants.¹⁸ From 1977 to 2012, the racial-ethnic composition of medical school applicants has changed as follows: Asians increased from 2.6% to 23%, Latinos increased from 2.6% to 8.7%, blacks increased from 6.4% to 8.1%, American Indians and Alaska Natives decreased from 0.33% to 0.25%, and whites decreased from 88% to 60%.¹⁹ Today, blacks and Latinos make up 13% and 17% of the U.S. population and constitute 6% and 5.5% of the physician workforce, respectively.^{20,21}

We describe the characteristics of pre-medical students who use CC pathways and the association of those characteristics with acceptance to medical school, intentions

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to serve underserved communities, and intentions to work primarily with minority populations. Given the diversity in the CC student body and prior studies identifying factors that support students' intent to practice in underserved and minority communities,^{2,5,22–24} we hypothesized that CC pathways are used differently by medical school applicants and matriculants with different characteristics, and that students who use CC pathways may be more likely to practice in underserved communities than those who did not use a CC pathway.

Method

Data sources

With approval from the University of California, Los Angeles institutional review board, we analyzed a deidentified subset of data from 45,266 medical school applicants from the 2012 Association of American Medical Colleges (AAMC) applicant file. Further analysis was performed on the 19,517 applicants who matriculated. A total of 1,824 applicant files were excluded because they only applied to non-American Medical College Application Service (AMCAS) participating schools. For example, medical schools in Texas are non-AMCAS. Our final study sample, after also excluding those with missing data (see "Other measures" section below), consisted of 40,491 applicants and 17,518 matriculants. Matriculant files were linked to responses to the 2012 Matriculating Student Questionnaire (MSQ),¹⁷ which is voluntary and administered annually to all first-year medical students in the United States. The MSQ collects information on student characteristics, premedical experiences, medical school selection processes, future career interests, educational debts, and financing. The MSQ response rate in 2012 was 72%.

College pathways

Using the Carnegie Classification of Institutions of Higher Education,²⁵ we determined the educational pathways students used prior to applying to or matriculating into medical school. From among 13 different Carnegie classifications of undergraduate degree-granting institutions, we created four categories: HS-CC (attended CC during high school), First-CC (attended a CC prior to a four-year university), Post-CC (attended a CC after graduating from

four-year university), and Non-CC (never attended a CC). This four-category pathway variable was our primary predictor. Our rationale for using three fundamentally different categories for students who attended a CC is grounded in previous work exploring the various pathways students use to gain acceptance to medical school.²⁶ HS-CC students concurrently enroll in a CC during high school because they are in an accelerated academic track that will help them gain acceptance to a four-year university. The First-CC group is composed of traditional CC students who obtain an associate's degree and then transfer to a four-year university. Post-CC students enrolled in a CC while or after completing a four-year university degree to complete additional premedical course work. There were no significant differences between students who attended a CC while or after completing a four-year university degree, and therefore we collapsed them into the Post-CC category. HS-CC and Post-CC students took a minimum of one course at the CC to qualify for these categories.

There were 1,329 applicants and 459 matriculants who used more than one CC pathway. We assigned students who used more than one CC pathway to a single category based on where they spent more time completing premedical course work, using the following algorithm: students who attended CC during high school and then again after graduating from high school but prior to a four-year university were categorized as First-CC instead of HS-CC; students who transferred to a four-year university and returned to a CC to complete course work were categorized as First-CC instead of Post-CC; and students who completed course work at a CC during high school and again after graduating from a four-year university were categorized as Post-CC instead of HS-CC.

Outcome measures

The primary outcome measure was acceptance to a U.S. MD-granting school or medical scientist training program (MSTP). Additional outcome measures were (1) plans to practice in an underserved community and (2) plans to work primarily with minority populations as reported on the MSQ.

Other measures

Students self-reported their sex (female or male), age, race-ethnicity, and parental education. We categorized race-ethnicity

as white, Asian, black, Latino, and multiple/other on their application file. Parental education was categorized on the basis of AAMC classification: less than college, college, master's degree, and professional or PhD degree. Academic variables were grade point average (GPA), most recent Medical College Admissions Test (MCAT) score, number of MCAT exams completed, number of applications, and years of premedical education. A total of 2,951 individuals who had missing data were excluded. Measures with missing data were college pathway ($n = 552$), gender ($n = 5$), parental education ($n = 1,715$), GPA ($n = 71$), and MCAT scores ($n = 608$).

Analysis

Stata version 13.0 (Stata Corporation LP 2013, College Station, Texas) was used to conduct analyses. Descriptive statistics were used to describe the variable frequencies, means, and percentages. Cross-tabulations were conducted to determine unadjusted proportions of student characteristics for each outcome. In bivariate analyses, tests for the statistical significance of unadjusted differences across groups were performed using a two-tailed t test of differences in means and χ^2 tests of differences in proportions when both variables were categorical.

We performed logistic regression to calculate the unadjusted odds ratio (OR) and adjusted odds ratios (AORs) of each outcome (acceptance to medical school, acceptance to an MSTP, plans to practice in an underserved community, and plans to work primarily with minority populations) using three different models comparing each CC pathway with the Non-CC pathway. We used a staged approach²⁷ to isolate the effects of student personal characteristics from academic characteristics. Inclusion of covariates was based on the literature on factors that influence admission to medical school and practice intentions, even if the variables had no statistically significant association with matriculation in the bivariate analyses.^{1,5,28} Model 1 regressions included our primary predictor without adjusting for covariates. Model 2 regressions included Model 1 variables plus personal characteristics: age, gender, race-ethnicity, and parental education. Model 3 regressions adjusted for Model 1 and 2 variables plus academic characteristics: GPA, MCAT scores,

and number of years in college after graduating from high school. A statistical significance level was set at $P < .05$ for all analyses.

We performed sensitivity analyses to determine whether there was a statistically significant interaction between race–ethnicity and CC pathway. The interaction variable was included in the final adjusted models for each outcome. Five separate multivariate logistic regression models, one for each race–ethnicity group, were conducted to further test the interactions.

Results

Characteristics of matriculants and applicants are shown in Table 1 and Supplemental Digital Table 1, <http://links.lww.com/ACADMED/A228>. A total

of 17,518 applicants matriculated into medical school in 2012, and 4,920 (28%) of them used one of the CC pathways; 1,920 (11%) used the HS-CC pathway, 895 (5%) used the First-CC pathway, and 2,105 (12%) used the Post-CC pathway (Table 1). The mean age of matriculants was 22 years (± 2.7), and 8,082 (46%) were women, with the First-CC pathway contributing the least women overall at 361 (4%).

Among Latinos, 538/1,566 (34%) used CC pathways, making Latinos the racial–ethnic group with the largest proportion of matriculants who used CC pathways. By comparison, 311/1,109 (28%) black matriculants, 2,715/9,905 (27%) white matriculants, and 963/3,628 (27%) Asian matriculants used CC pathways. Blacks made up the smallest percentage of matriculants who used the HS-CC pathway (76/1,109 [7%]), compared

with whites (1082/9,905 [11%]), Asians (416/3,628 [12%]), and Latinos (175/1,566 [11%]). One hundred thirty-one of 1,566 (8%) Latinos used the First-CC pathway, compared with 449/9,905 (4.5%) whites. Latino and black matriculants made up the largest percentage of students who used the Post-CC pathway compared with other racial–ethnic groups.

Among matriculants on the First-CC pathway, 304/895 (34%) had parents with less than a college education compared with 1,683/12,598 (13%) of those on the Non-CC pathway. The average matriculant GPA and MCAT scores varied slightly between pathways. A higher percentage of matriculants whose parents had less than a college education used the CC pathways across all race–ethnicity categories, compared with those who used the Non-CC (see Figure 1).

Table 1

Characteristics by Premedical College Pathway for Matriculants to U.S. Medical Schools Included in the American Medical College Application Service, 2012

Characteristics	Non-CC	HS-CC	First-CC	Post-CC	Totals	P value ^a
All matriculants,^b no. (%)	12,598 (71.9)	1,920 (11.0)	895 (5.1)	2,105 (12.02)	17,518 (100)	
MD only,^c no. (%)	11,984 (71.5)	1,845 (11.0)	867 (5.2)	2,055 (12.3)	16,751 (100)	< .001
MSTP, no. (%)	614 (80.1)	75 (9.8)	28 (3.7)	50 (6.5)	767 (100)	< .001
Mean age in years (SD)	21.8 (2.5)	21.9 (2.4)	23.2 (3.4)	23.2 (3.6)	22.0 (2.72)	< .001
Female, no. (%)	5,845 (72.3)	901 (11.2)	361 (4.5)	975 (12.1)	8,082 (100)	.32
Race–ethnicity						< .001
White, no. (%)	7,190 (72.6)	1,082 (10.9)	449 (4.5)	1,184 (11.9)	9,905 (100)	
Asian, no. (%)	2,665 (73.5)	416 (11.5)	179 (4.9)	368 (10.1)	3,628 (100)	
Black, no. (%)	798 (71.9)	76 (6.9)	75 (6.8)	160 (14.4)	1,109 (100)	
Latino, no. (%)	1,028 (65.6)	175 (11.2)	131 (8.4)	232 (14.8)	1,566 (100)	
Multiple/other race, no. (%)	917 (70)	171 (13.1)	61 (4.7)	161 (12.3)	1,310 (100)	
Parental education						< .001
Less than college, no. (%)	1,683 (59.3)	395 (13.9)	304 (10.7)	456 (16.1)	2,838 (100)	
College, no. (%)	2,935 (68.9)	529 (12.4)	226 (5.3)	569 (13.4)	4,259 (100)	
Master's, no. (%)	3,151 (72.7)	485 (11.2)	178 (4.1)	518 (11.9)	4,332 (100)	
PhD or professional degree, no. (%)	4,829 (79.3)	511 (8.4)	187 (3.1)	562 (9.2)	6,089 (100)	
Mean GPA (SD)	3.68 (0.25)	3.71 (0.24)	3.69 (0.26)	3.64 (0.28)	3.68 (0.26)	< .001
Mean MCAT score (SD)	31.5 (3.99)	31.1 (3.90)	29.9 (3.99)	30.3 (3.93)	31.3 (4.00)	.61
Mean no. (SD) of MCAT exams taken	1.47 (0.74)	1.50 (0.75)	1.59 (0.80)	1.63 (0.88)	1.50 (0.77)	< .001
Mean no. (SD) of applications submitted	16.2 (10.9)	16.7 (12.6)	17.3 (12.7)	15.6 (11.7)	16.2 (11.3)	< .001
No. (SD) of years in college before application to medical school	4.6 (1.8)	6.4 (3.0)	6.8 (3.9)	6.2 (3.7)	5.1 (2.5)	< .001

Abbreviations: Non-CC indicates applicants who never used any of the community college pathways; HS-CC, applicants who attended a community college while in high school and prior to graduating from high school; First-CC, applicants who attended a community college after graduating from high school and prior to transferring to a four-year university; Post-CC, applicants who attended a community college during or after graduating from a four-year university; MSTP, Medical Scientist Training Program or MD–PhD dual-degree program; GPA, grade point average; MCAT, Medical College Admission Test; SD, standard deviation.

^aRepresents significance based on χ^2 test for proportional distribution.

^bA total of 16,751 out of the 17,537 applicants accepted matriculated into medical school in 2012. A total of 186 out of the 1,744 applicants to an MSTP matriculated in an MD-only program in 2012.

^cA total of 767 out of the 806 accepted applicants to an MSTP program matriculated in an MSTP program in 2012.

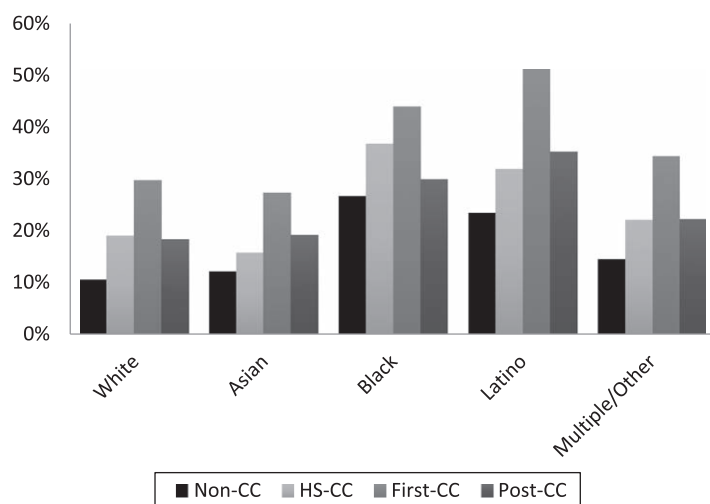


Figure 1 Percentage of 2012 U.S. MD-granting medical school matriculants whose parents had less than a college education by race-ethnicity and premedical college pathway. Non-CC indicates applicants who never used any of the community college pathways; HS-CC, applicants who attended a community college while in high school and prior to graduating from high school; First-CC, applicants who attended a community college after graduating from high school and prior to transferring to a four-year university; Post-CC, applicants who attended a community college during or after graduating from a four-year university.

Table 2 shows the unadjusted percentages for matriculants' acceptance rates to medical schools and MSTPs, matriculants' intentions to practice in an underserved community, and matriculants' intentions to work primarily with minority populations. A total of 17,537/40,491 (43%) and 806/1,744 (46%) applicants were accepted to medical school and an MSTP program, respectively. Acceptance rates to medical school varied by pathway: 12,574/26,074 (48%) for Non-CC; 1,923/4,168 (46%) for HS-CC; 897/2,884 (31%) for First-CC; and 2,143/5,621 (38%) for Post-CC (Table 2).

Among matriculants who reported on the MSQ that they intended to locate their practice in an underserved community, 202/551 (37%) used the First-CC pathway ($P < .001$) as compared with 2,103/7,467 (28%) in the Non-CC pathway. Among matriculants, 2,058/10,441 (20%) reported on the MSQ that they intended to work primarily with minority populations, and this did not vary significantly by pathway ($P < .05$).

Figure 2 illustrates unadjusted differences in outcomes by race-ethnicity and CC

pathway. Students who went to a four-year university after graduating from high school and never attended a CC made up the largest proportion of students accepted to medical school and MSTP programs across all race-ethnicity groups. Irrespective of race-ethnicity, applicants who used the First-CC pathway were less likely to be accepted to medical school or an MSTP compared with those who used other college pathways. A higher percentage of medical students who used the First-CC pathway, except for the multiple/other race group, indicated an intention to practice in an underserved area compared with those who used the Non-CC pathway. Among all pathways, a higher percentage of black and Latino matriculants indicated intentions to practice in underserved areas and to work primarily with minority populations compared with other race-ethnicity groups.

Table 3 includes the results of the logistic regression analyses for each outcome. In the unadjusted model (Model 1), First-CC pathway students had lower odds of being accepted into medical school ($OR = 0.49$; 95% $CI = 0.45-0.53$; $P < .05$). After adjusting for student personal and academic characteristics (Model 3), the effect was slightly attenuated but statistically significant ($AOR = 0.68$; 95% $CI = 0.61-0.75$; $P < .05$). In the unadjusted model (Model 1), First-CC pathway students had higher odds ($OR = 1.48$; 95% $CI = 1.24-1.77$; $P < .05$) of having intentions to practice in underserved communities. After adjusting for student personal and academic characteristics (Model 3), this relationship was slightly attenuated but statistically significant ($AOR = 1.26$; 95% $CI = 1.05-1.53$; $P < .05$). In Model 1, First-CC students were more likely to plan to work primarily with minority populations compared with Non-CC students. This effect was no longer statistically significant after adjusting for student characteristics.

The race-ethnicity interaction with CC pathway was largely insignificant for all outcomes. However, the Latino*HS-CC and Latino*First-CC interactions were both significant ($P < .05$) for acceptance to medical school. The white*HS-CC interaction was also significant ($P < .05$) for intentions to practice in an underserved community. Supplemental Digital Table 2, <http://links.lww.com/ACADMED/A228>, shows significantly lower odds of acceptance to medical school for all race-ethnicity groups who

Table 2

Unadjusted Acceptance Rates for U.S. MD-Granting and MSTP Programs, and Percentages of Matriculants With Intentions to Practice in an Underserved Community and Intentions to Work Primarily With Minority Populations as Reported on the Matriculating Student Questionnaire, 2012

Pathway/ outcome	Accepted to MD-granting school	Accepted to MSTP	Intentions to practice in an underserved community	Intentions to primarily work with minority population
Non-CC, no. (%)	12,574/26,074 (48)	649/1,275 (51)	2,103/7,467 (28)	1,456/7,496 (19)
HS-CC, no. (%)	1,923/4,168 (46)	75/187 (40)	353/1,123 (31)	207/1,131 (18)
First-CC, no. (%)	897/2,884 (31)	30/112 (27)	202/551 (37)	122/524 (23)
Post-CC, no. (%)	2,143/5,621 (38)	52/170 (31)	421/1,294 (33)	273/1,290 (21)
Totals, no. (%)	17,537/38,747 (45)	806/1,744 (46)	3,079/10,435 (30)	2,058/10,441 (20)
P value ^a	< .001	< .001	< .001	.051

Abbreviations: MSTP indicates Medical Scientist Training Program or MD-PhD dual-degree program; Non-CC, applicants who never used any of the community college pathways; HS-CC, applicants who attended a community college while in high school and prior to graduating from high school; First-CC, applicants who attended a community college after graduating from high school and prior to transferring to a four-year university; Post-CC, applicants who attended a community college during or after graduating from a four-year university.

^aRepresents significance based on χ^2 test for proportional distribution.

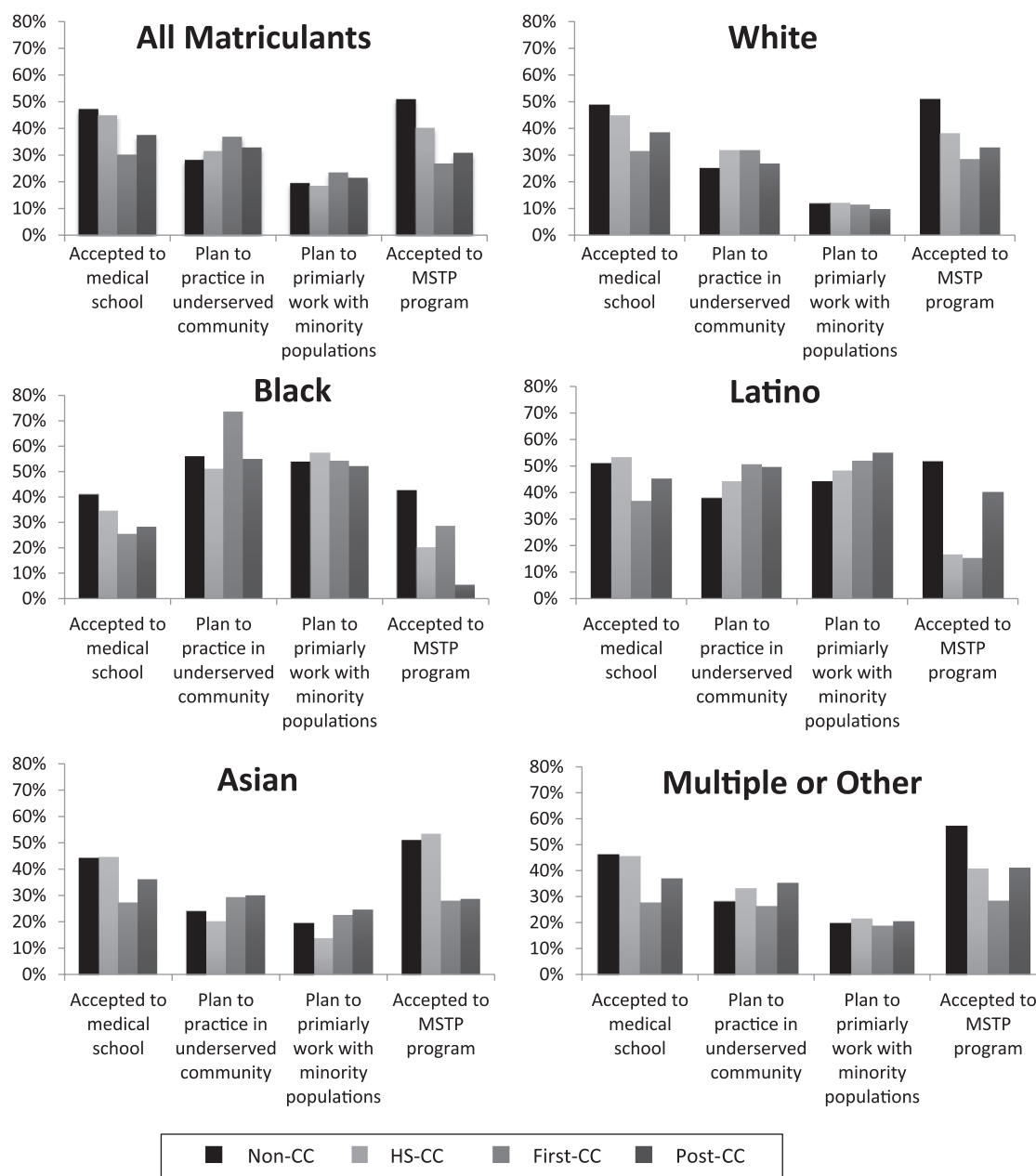


Figure 2 Unadjusted primary outcomes for 2012 U.S. MD-granting medical school matriculants by race-ethnicity and community college pathway. Non-CC indicates applicants who never used any of the community college pathways; HS-CC, applicants who attended a community college while in high school and prior to graduating from high school; First-CC, applicants who attended a community college after graduating from high school and prior to transferring to a four-year university; Post-CC, applicants who attended a community college during or after graduating from a four-year university.

used the First-CC pathway, except for black applicants, compared with those on the Non-CC pathway ($P < .05$).

Discussion

To our knowledge, this is the first study to describe the contributions of the CC as a pathway to U.S. MD-granting schools. Approximately one-third of applicants in 2012 used a CC pathway to medical school. Thirty-four percent of the Latino matriculants in 2012 used one of the CC pathways, and given the

population projections, there is a huge need to increase the pool of qualified Latino medical school applicants to ensure adequate representation within the physician workforce. Without the CC pathways, Latinos would have only made up 1,028/17,518 (6%) of 2012 matriculants, returning the percentage to 1980s levels.²⁹

Medical students who used the First-CC pathway were more likely to have intentions to practice in an underserved community compared with all other

pathways. First-CC students likely grew up in underserved communities, and their exposure to a more resource-limited environment may have reinforced their future practice intentions. CC student practice intentions may persist, and our findings are consistent with prior studies showing that personal characteristics influence physician practice patterns.^{5,8,28} We also found that the First-CC pathway was independently associated with not getting accepted to medical school compared with other pathways. It may be more difficult for students who

Table 3

Predictors of Acceptance to MD-Granting and MSTP Programs, and Practice Intentions Among U.S. Medical School Matriculants, 2012

Model 1 ^a	Accepted to MD-granting school, OR (95% CI)	Accepted to MSTP, OR (95% CI)	Plan to practice in an underserved community, OR (95% CI)	Plan to work primarily with minority populations, OR (95% CI)
Non-CC	Ref	Ref	Ref	Ref
HS-CC	0.91 (0.86–0.98) ^d	0.65 (0.47–0.88) ^d	1.17 (1.02–1.34) ^d	0.93 (0.79–1.09)
First-CC	0.49 (0.45–0.53) ^d	0.35 (0.23–0.54) ^d	1.48 (1.24–1.77) ^d	1.26 (1.02–1.55) ^d
Post-CC	0.67 (0.63–0.71) ^d	0.43 (0.30–0.60) ^d	1.23 (1.08–1.40) ^d	1.11 (0.96–1.29)
Model 2 ^b	Accepted to MD-granting school, AOR (95% CI)	Accepted to MSTP, AOR (95% CI)	Plan to practice in an underserved community, AOR (95% CI)	Plan to work primarily with minority populations, AOR (95% CI)
Non-CC	Ref	Ref	Ref	Ref
HS-CC	0.96 (0.90–1.02)	0.70 (0.51–0.97) ^d	1.17 (1.01–1.34) ^d	0.93 (0.78–1.10)
First-CC	0.59 (0.55–0.65) ^d	0.45 (0.28–0.71) ^d	1.27 (1.05–1.53) ^d	0.98 (0.77–1.23)
Post-CC	0.77 (0.73–0.82) ^d	0.58 (0.40–0.83) ^d	1.04 (0.91–1.19)	0.93 (0.79–1.09)
Model 3 ^c	Accepted to MD-granting school, AOR (95% CI)	Accepted to MSTP, AOR (95% CI)	Plan to practice in an underserved community, AOR (95% CI)	Plan to work primarily with minority populations, AOR (95% CI)
Non-CC	Ref	Ref	Ref	Ref
HS-CC	0.97 (0.90–1.06)	0.78 (0.52–1.17)	1.17 (1.01–1.36) ^d	0.92 (0.78–1.10)
First-CC	0.68 (0.61–0.75) ^d	0.43 (0.25–0.74) ^d	1.26 (1.04–1.53) ^d	0.97 (0.76–1.22)
Post-CC	0.95 (0.88–1.02)	0.68 (0.44–1.04)	1.02 (0.89–1.17)	0.89 (0.76–1.05)

Abbreviations: OR indicates odds ratio; MSTP, Medical Scientist Training Program or MD–PhD dual-degree program; Non-CC, applicants who never used any of the community college pathways; HS-CC, applicants who attended a community college while in high school and prior to graduating from high school; First-CC, applicants who attended a community college after graduating from high school and prior to transferring to a four-year university; Post-CC, applicants who attended a community college during or after graduating from a four-year university; AOR, adjusted odds ratio; GPA, grade point average; MCAT, Medical College Admission Test; SD, standard deviation; Ref, reference.

^aUnadjusted.

^bAdjusted for age, gender, race–ethnicity, and parental education.

^cAdjusted for age, gender, race–ethnicity, parental education, MCAT score, GPA, and number of years in college before application to medical school.

^d $P < .05$, using Non-CC as reference group.

attend a CC to get into medical school or into an MSTP because of the limited premedical opportunities at nonresearch institutions, other socioeconomic status (SES)-related challenges, or a perception, whether it is accurate or not, they are not as academically well prepared as students who only attend four-year colleges or universities.

We found variation in matriculation rates among the different CC pathway groups despite relatively small differences in GPA and MCAT scores. Holistic review processes equally value capacity for growth and emotional resilience (reflected in the distance one has traveled to be ready for medical school),³⁰ and our results suggest these issues still need additional attention in the medical school admission process. Adopting holistic review into the standard medical school admission process may be one way to ensure

qualified candidates gain admission in spite of the nontraditional pathways they take to medical school.

The CC system represents a potential source of student diversity for medical schools; however, there are significant challenges to enhancing the pipeline from CC to medical school. First, whereas many First-CC students aspire to transfer to a four-year university, only approximately 37% of students who graduate from high school and begin at the CC level eventually do.³¹ There is also a disparity in terms of who actually successfully transfers. Studies have concluded that students who transfer from CCs to four-year colleges are of higher SES, have more academic preparation, are less likely to be URM, and are less likely to be women.^{32,33} In keeping with these earlier findings, our results show that the medical students who used a First-CC

pathway were more likely to be URM and the first in their families to attend college. Further, the smallest percentage of women matriculants used the First-CC pathway, yet they represent the majority of the entire U.S. CC student population.¹¹ Finally, the financial costs of pursuing a medical education may be prohibitive for most CC students. Financial aid programs, scholarships, and well-funded premedical counseling programs to support students earlier in their educational pathways at the CC level are needed.

A limitation of this study is the cross-sectional design and our inability to include other personal or academic factors in our analyses. The admissions process includes evaluating a wide variety of applicant data related to academic preparation, personal attributes, and extracurricular experiences to assess applicants' strengths and to determine

their likelihood of success in medical school; so the exclusion of some of these data could have affected our results. Further, our dataset did not include students who also applied to or matriculated into DO-granting medical schools and excluded students who applied to or matriculated to non-AMCAS medical schools. Finally, the responses from the MSQ are self-reported and are subject to bias. We included intention to practice in underserved areas or work with minority populations, but we do not know if students who expressed these interests will ultimately work in these communities.

Over the past three decades, growth in the U.S. public higher education system has occurred almost exclusively in the CC sector.³⁴ CCs will remain a relatively affordable and accessible option for millions of Americans, and enrollment will likely continue to increase. Although many medical school recruitment and outreach efforts are strictly targeted at four-year universities, ample opportunities may exist to support CC students pursuing careers in medicine. More research is needed to understand how medical schools can better support CCs and their students who have a desire to pursue a medical education and serve the underserved. Expanding this pathway and developing interventions to help CC students gain admission to medical schools in greater numbers may be an important way to diversify the medical student body and train the physicians needed to help address health disparities.

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References

- Xu G, Fields SK, Laine C, Veloski JJ, Barzansky B, Martini CJ. The relationship between the race/ethnicity of generalist physicians and their care for underserved populations. *Am J Public Health*. 1997;87:817–822.
- Smedley BD, Butler AS, Bristow LR; Institute of Medicine (U.S.); Committee on Institutional and Policy-Level Strategies for Increasing the Diversity of the U.S. Health Care Workforce, Institute of Medicine (U.S.). Board on Health Sciences Policy. In: *The Nation's Compelling Interest*. Washington, DC: National Academies Press; 2004.
- Grumbach K, Mendoza R. Disparities in human resources: Addressing the lack of diversity in the health professions. *Health Aff (Millwood)*. 2008;27:413–422.
- Cohen JJ, Gabriel BA, Terrell C. The case for diversity in the health care workforce. *Health Aff (Millwood)*. 2002;21:90–102.
- Komaromy M, Grumbach K, Drake M, et al. The role of black and Hispanic physicians in providing health care for underserved populations. *N Engl J Med*. 1996;334:1305–1310.
- Saha S, Guiton G, Wimmers PF, Wilkerson L. Student body racial and ethnic composition and diversity-related outcomes in US medical schools. *JAMA*. 2008;300:1135–1145.
- Milem JE. The educational benefits of diversity: Evidence from multiple sectors. In: Chang MJ, Witt D, Jones J, Hakuta K (eds). *Compelling Interest: Examining the Evidence on Racial Dynamics in Higher Education*. Stanford, Calif.: Stanford University Press; 2003:126–169.
- Cantor JC, Miles EL, Baker LC, Barker DC. Physician service to the underserved: Implications for affirmative action in medical education. *Inquiry*. 1996;33:167–180.
- Roter D, Hall J, Aoki Y. Physician gender effects in medical communication. *JAMA*. 2002;288:756–764.
- Carnevale AP, Strohl J. *Separate and Unequal: How Higher Education Reinforces the Intergenerational Reproduction of White Racial Privilege*. Washington, DC: Georgetown University Center on Education and the Workforce; 2013. <http://cew.georgetown.edu/separateandunequal>. Accessed May 13, 2014.
- Knapp LG, Kelly-Reid JE, Ginder SA. Enrollment in Postsecondary Institutions, Fall 2009; Graduation Rates, 2003 & 2006 Cohorts; and Financial Statistics, Fiscal Year 2009. First Look. Washington, DC: National Center for Education Statistics; 2011. NCES 2011-230. <http://nces.ed.gov/pubs2011/2011230.pdf>. Accessed May 13, 2014.
- Bailey T, Jenkins D, Leinbach T. What We Know About Community College Low-Income and Minority Student Outcomes: Descriptive Statistics from National Surveys. 2005. <http://ccrc.tc.columbia.edu/media/k2/attachments/low-income-minority-completion.pdf>. Accessed May 13, 2014.
- Kahlenberg RD. *Rewarding Strivers: Helping Low-Income Students Succeed in College*. New York, NY: Century Foundation Press; 2010.
- Nahvi FA. Letters to the editor: The privilege gap in medicine. *Acad Med*. 2013;88:907.
- Jolly P. Diversity of U.S. medical students by parental income. AAMC Analysis in Brief. January 2008;8. <https://www.aamc.org/download/102338/data/aibvol8no1.pdf>. Accessed July 1, 2013.
- Sabalís R. Medical Educational Costs and Student Debt: A Working Group Report to the AAMC Governance. Washington, DC: Association of American Medical Colleges; 2005. <http://www.neomed.edu/students/es/finaid/secure/step5/edcostsanddebt.pdf>. Accessed May 13, 2014.
- Association of American Medical Colleges. *Matriculating Student Questionnaire: All Schools Summary Report*. Washington, DC: Association of American Medical Colleges; December 2012. <https://www.aamc.org/download/323378/data/msq2012report.pdf>. Accessed May 13, 2014.

- 18 Alexander C, Chen E, Grumbach K. How leaky is the health career pipeline? Minority student achievement in college gateway courses. *Acad Med*. 2009;84:797–802.
- 19 Castillo-Page L. Diversity in Medical Education: Facts & Figures 2012. Washington, DC: Association of American Medical Colleges; 2012. <https://members.aamc.org/eweb/upload/Diversity%20in%20Medical%20Education%20Facts%20and%20Figures%202012.pdf>. Accessed July 1, 2013.
- 20 United States Census Bureau. Overview of Race and Hispanic Origin: 2010. Issued March 2011. <http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf>. Accessed May 13, 2014.
- 21 Castillo-Page L. Diversity in the Physician Workforce: Facts & Figures 2010. Washington, DC: Association of American Medical Colleges; 2012. <https://members.aamc.org/eweb/upload/Diversity%20in%20the%20Physician%20Workforce%20Facts%20and%20Figures%202010.pdf>. Accessed May 13, 2014.
- 22 Saha S, Shipman SA. Race-neutral versus race-conscious workforce policy to improve access to care. *Health Aff (Millwood)*. 2008;27:234–245.
- 23 Grumbach K, Hart LG, Mertz E, Coffman J, Palazzo L. Who is caring for the underserved? A comparison of primary care physicians and nonphysician clinicians in California and Washington. *Ann Fam Med*. 2003;1:97–104.
- 24 Lupton K, Vercammen-Grandjean C, Forkin J, Wilson E, Grumbach K. Specialty choice and practice location of physician alumni of University of California premedical postbaccalaureate programs. *Acad Med*. 2012;87:115–120.
- 25 Carnegie Foundation for the Advancement of Teaching. The Carnegie Classification of Institutions of Higher Education. <http://classifications.carnegiefoundation.org/>. Accessed May 13, 2014.
- 26 Grbic D, Garrison G. From community college to physician: Diversity and educational pathways to medical school. Poster presented at: Association for Institutional Research National Forum; May 23, 2011; Toronto, Ontario, Canada.
- 27 Moreno G, Walker KO, Morales LS, Grumbach K. Do physicians with self-reported non-English fluency practice in linguistically disadvantaged communities? *J Gen Intern Med*. 2011;26:512–517.
- 28 Moy E, Bartman BA. Physician race and care of minority and medically indigent patients. *JAMA*. 1995;273:1515–1520.
- 29 Cooper RA. Medical schools and their applicants: An analysis. *Health Aff (Millwood)*. 2003;22:71–84.
- 30 Witzburg RA, Sondheimer HM. Holistic review—shaping the medical profession one applicant at a time. *N Engl J Med*. 2013;368:1565–1567.
- 31 Adelman C. The Toolbox Revisited: Paths to Degree Completion From High School Through College. Washington, DC: U.S. Department of Education; 2006. <http://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf>. Accessed May 13, 2014.
- 32 Dougherty K, Kienzl G. It's not enough to get through the open door: Inequalities by social background in transfer from community colleges to four-year colleges. *Teach Coll Rec*. 2006;108:452–487.
- 33 Surette B. Transfer from two-year to four-year college: An analysis of gender differences. *Econ Educ Rev*. 2001;20: 151–163.
- 34 Desrochers DM, Lenihan CM, Wellman JV. Trends in College Spending 1998–2008: Where Does the Money Come from? Where Does It Go? What Does It Buy? A Report of the Delta Cost Project. Washington, DC: Delta Project on Postsecondary Education Costs, Productivity and Accountability; 2010. <http://www.deltacostproject.org/sites/default/files/products/Trends-in-College-Spending-98-08.pdf>. Accessed May 13, 2014.