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The Role of Community Colleges in Health Professions Diversity

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Questions

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The Role of Community Colleges in Health Professions Diversity

Background

Increasing workforce diversity is a longstanding goal of many health professions, particularly those requiring advanced degrees. While the underrepresentation of Black and Hispanic students in medical school receives significant attention, less attention is on the diversity of other health professions that require advanced degrees, including dentistry (Poole et al., 2022), pharmacy (Wall et al., 2015), occupational therapy (Brown et al., 2021), and physical therapy (Moerchen et al., 2018). All four professions are below population parity regarding Black and Hispanic diversity in the workforce and the training pipeline, pointing to the need for renewed efforts to attract more Black and Hispanic students into these professions (Salsberg et al., 2021).

The diversity of health care providers is important for several well-documented reasons (Farrell et al., 2022). First, minority providers are often more likely to care for minority and disadvantaged patients (e.g., uninsured individuals, Medicaid beneficiaries Marrast et al., 2014). While evidence about the impact of race/ethnicity concordance between patients and providers on outcomes is mixed, having more diverse providers has been shown to improve communication between patients and providers, which is sometimes linked to better outcomes and lower costs (Jetty et al., 2021; Shen et al., 2018). A greater presence of minority providers and trainees can be helpful for non-minority providers who work alongside them. White providers who train in more diverse settings also perceive themselves as more sensitive to equity concerns and better equipped to care for minority populations (Saha et al., 2008).

Community colleges (CCs) have long been noted as an important pathway for increasing the diversity of health professions as they are a major entry point to post-secondary education for low-income, minority, and rural students (The Sullivan Commission, 2003). While much of the attention around the role of CCs has focused on the nursing pipeline (Colville et al., 2015), recent studies find that CCs are an important pipeline for diversifying medical school (Talamantes et al., 2018), and physician assistant matriculants (Luo et al., 2022). In addition, CC graduates who become physicians are more likely to work in underserved areas (Talamantes et al., 2014) and high-need specialties such as family medicine (Talamantes et al., 2018).

Despite the importance of CCs as a workforce development tool for states and communities, state funding for two-year and four-year colleges is lower than before the 2008-2009 Great Recession (Mitchell et al., 2019). Greater state funding of higher education is associated with higher graduation rates, including associate degrees (Deming et al., 2017). Funding cuts have been found to severely impact Black and Hispanic students' enrollment and degree completion (Monarrez et al., 2021). Tuition increases have also been inversely associated with student diversity at CCs (Allen & Wolniak, 2018).

This study builds on prior work to examine the contribution of CCs to the diversity of other health professions that require advanced degrees, including dentistry, pharmacy, occupational therapy, and physical therapy. The study also examines associations between state investments in CCs and the cost of attending CCs and the diversity of health professions graduates in the state.

Objectives

1. To examine the contribution of CCs to the diversity of health professions that require advanced degrees, including dentistry, pharmacy, occupational therapy, and physical therapy.
2. To examine associations between CC availability/enrollment, state investments in CCs, cost of attending CCs, and diversity of health professions graduates with CC backgrounds.

Research Questions:

1. What proportion of dentistry, pharmacy, occupational therapy, and physical therapy graduates have a CC background? How does this vary by state?
2. Is the availability/density of CCs (measured by enrollment per population) in a state associated with a greater proportion of minority health professions graduates in that state?
 - Hypothesis: States with higher availability/density of CCs will have a higher percentage of minority CC health professions graduates because it is easier for them to access CC education when there are more seats.
3. Is higher per-student state funding for CCs associated with a greater proportion of minority health professions graduates in that state?
 - Hypothesis: States with higher funding of CCs will have a higher percentage of minority CC health professions graduates because better-funded CCs can offer more resources/support to students (including minority students) to support their success in CC and beyond.
4. Is lower average tuition for CCs in a state associated with a greater proportion of minority health professions graduates?
 - Hypothesis: States with lower CC tuition/fees will have a higher percentage of minority CC health professions graduates because CC education is more accessible; it's cheaper for minority students who may have fewer financial resources to pay for school and/or need to pay for school themselves.

Methods

Data Sources

We used data from the National Student Clearinghouse (NSC) (Shapiro & Tang, 2019) to quantify how many dentistry, pharmacy, occupational therapy, and physical therapy graduates in the most recent two graduating cohorts (2018-2019 and 2019-2020) had CC backgrounds by race/ethnicity and state. The NSC is a national nonprofit organization that collects student-level data from more than 3,600 colleges and universities on enrollment and degree completion each year. Its data represent around 97 percent of all degree completions each year, and it is one of the only data resources that tracks individual students' higher education pathways over time (National Student Clearinghouse Research Center, n.d.). In addition to its role in degree documentation and verification for higher education institutions and employers, the NSC also makes its data available for research through the National Student Clearinghouse Research Center. We collaborated with researchers at the NSC Research Center, who conducted the analyses of student-level data and shared the aggregated numbers by profession, state, race/ethnicity, sex, and CC background with the GW team for the detailed analyses below.

The NSC analysis identified students according to their "first enrollment" or first record in the NSC data, meaning that only students whose first higher education enrollment was in a CC were included in the CC

category. These could consist of dual enrollment during high school or initial enrollment (degree-seeking or not) after high school and before any subsequent higher education enrollment. Students who may have enrolled in CC courses or programs after registering at other types of institutions (e.g., taking courses during or after a degree program at 4-year public or private colleges) were not included in the CC category.

We used the Integrated Postsecondary Education Data System (IPEDS) to obtain data on CC enrollment, funding, and tuition/fees by state to answer the state policy-related research questions. The National Center for Education Statistics maintains IPEDS. Its public use data include annual college-level data on institutional characteristics, programs offered, student enrollment and graduations, financing, and tuition/fees (National Center for Education Statistics, n.d.). We accessed IPEDS datasets on admissions and enrollment, school financing, and tuition/fees through the Urban Institute's Education Data Explorer (<https://educationdata.urban.org/data-explorer/about>) from 2010 to the most recently available (2017 to 2019, depending on the dataset), with the assumption that most students completing graduate degrees in 2019 or 2020 who started in CCs would have been enrolled in CCs during this period.

After obtaining the relevant data points (estimated FTE students from the admissions/enrollment dataset, state and local appropriations from the school financing dataset, and full-time tuition and fees from the tuition/fees dataset), we merged the data using the IPEDS UnitID variable. We reshaped the data to include a single observation per school, including variables for each data point and year. We used data on state appropriations and state/local appropriations combined to account for differences in state funding models. For example, CCs in some states receive virtually zero local appropriations, while those in other states receive more from local appropriations than from state appropriations (Koh et al., 2019). To reduce the dataset to only CC, we linked the full IPEDS dataset created by IPEDS UnitID with a list of CCs published by the Columbia Community College Research Center (Fink & Jenkins, 2020) and retained only the data on CCs.

We used this dataset to calculate total CC FTEs, state and local appropriations to CCs, and average full-time CC tuition and fees by state and year. Next, we used this information to create a dataset of state-level year-by-year data on CC student FTEs, state and local appropriations to CCs, and average CC tuition and fees. We reshaped these data to create a dataset to include a single observation per state, including variables for each CC data point and year, as well as averages over time (e.g., average total CCs FTEs in a state each year and on average from 2010-2018). Finally, we linked these data points with U.S. Census state population estimates for each year (2010-2019) to calculate CC student FTEs per population per year.

We also used data from the 2020 American Community Survey 5-year public use file (U.S. Census Bureau, 2022) to calculate the percentage of the population aged 20-35 that was Black or Hispanic nationally and by state for use in the "diversity index" calculations for health professions graduates (CC background and all) described below. We accessed the ACS data through IPUMS USA (<https://usa.ipums.org/usa/>).

Analysis Methods

Overall/National Descriptive Analyses by Profession

To address Research Question #1, we performed descriptive analyses to compare the prevalence of CC background among health professions graduates by profession and demographic group. We used the NSC aggregated national data on each profession to calculate the percentage of dentistry, pharmacy, occupational therapy, and physical therapy graduates that had a CC background, overall and by

race/ethnicity. We also used the national data to compare the distribution of CC background graduates by race/ethnicity in each profession to the distribution of all graduates by race/ethnicity.

We also calculated a "diversity index" for each profession's graduates (all and CC background only), comparing the percentage of Black/Hispanic graduates in each profession to the percentage of the US population ages 20-35 that is Black/Hispanic. The diversity index has been used to measure the relative diversity of health professions graduates compared to the population using dental school-level data, among others (Salsberg et al., 2022).

State-Level Descriptive Analyses by Profession

We used the NSC state-level data to calculate several indicators, including the following:

- Percent of graduates with CC background by profession in each state
- Percent of CC background graduates who are Black and/or Hispanic in each state (with "unknown" race/ethnicity category removed from denominator)
- Diversity index of CC background graduates (percent Black/Hispanic graduates vs. percent of state population ages 20-35 that is Black/Hispanic)

Because NSC rules require masking numbers between 1 and 9 in datasets provided to external researchers, we were not always able to calculate the percentage of Black and/or Hispanic graduates with precision. In cases where we did not have concrete numbers (either because a Black or Hispanic category value was masked and/or because an "unknown" race/ethnicity value was masked), we calculated the maximum and minimum possible values using the data we had. We used the midpoint of these values for inclusion in the descriptive results and regression models shown.

Regression Analyses by Profession

To address Research Questions #2, #3, and #4, we used linear regression models to examine associations between state-level CC availability/enrollment, state and local appropriations, average tuition/fees, and the diversity of graduates for each profession.

We examined associations between the percentage of graduates with a CC background and state-level variables using the following simple regression models:

- % CC grads = $b_0 + b_1 \text{CC FTEs/population}$
- % CC grads = $b_0 + b_1 \text{CC state appropriations/FTE}$
- % CC grads = $b_0 + b_1 \text{CC state \& local appropriations/FTE}$
- % CC grads = $b_0 + b_1 \text{CC tuition \& fees/FTE}$

We also used the following multiple regression models to examine the associations holding other factors constant (including separate models for two different permutations of the funding variable):

- % CC grads = $b_0 + b_1 \text{CC FTEs/population} + b_2 \text{CC state appropriations/FTE} + b_3 \text{CC tuition \& fees/FTE}$
- % CC grads = $b_0 + b_1 \text{CC FTEs/population} + b_2 \text{CC state \& local appropriations/FTE} + b_3 \text{CC tuition \& fees/FTE}$

We examined associations between the percentage of CC background graduates that were Black/Hispanic and state-level variables using the following simple regression models:

- % Black/Hispanic CC grads = $b_0 + b_1 \text{CC FTEs/population}$
- % Black/Hispanic CC grads = $b_0 + b_1 \text{CC state appropriations/FTE}$
- % Black/Hispanic CC grads = $b_0 + b_1 \text{CC state \& local appropriations/FTE}$
- % Black/Hispanic CC grads = $b_0 + b_1 \text{CC tuition \& fees/FTE}$

We also used the following multiple regression models to examine the associations holding other factors constant (including separate models for two different permutations of the funding variable):

- % Black/Hispanic CC grads = $b_0 + b_1 \text{CC FTEs/population} + b_2 \text{CC state appropriations/FTE} + b_3 \text{CC tuition \& fees/FTE}$
- % Black/Hispanic CC grads = $b_0 + b_1 \text{CC FTEs/population} + b_2 \text{CC state \& local appropriations/FTE} + b_3 \text{CC tuition \& fees/FTE}$

Finally, we modeled associations between the Black/Hispanic diversity index of CC background graduates and state-level variables using the following simple regression models:

- CC Black/Hispanic diversity index = $b_0 + b_1 \text{CC FTEs/population}$
- CC Black/Hispanic diversity index = $b_0 + b_1 \text{CC state appropriations/FTE}$
- CC Black/Hispanic diversity index = $b_0 + b_1 \text{CC state \& local appropriations/FTE}$
- CC Black/Hispanic diversity index = $b_0 + b_1 \text{CC tuition \& fees/FTE}$

We also used the following multiple regression models to examine the associations holding other factors constant (including separate models for two different permutations of the funding variable):

- CC Black/Hispanic diversity index = $b_0 + b_1 \text{CC FTEs/population} + b_2 \text{CC state appropriations/FTE} + b_3 \text{CC tuition \& fees/FTE}$
- CC Black/Hispanic diversity index = $b_0 + b_1 \text{CC FTEs/population} + b_2 \text{CC state \& local appropriations/FTE} + b_3 \text{CC tuition \& fees/FTE}$

In all models, we coded the percentage CC and Black/Hispanic CC dependent variables as percentage points (e.g., 60.3% was coded as 60.3 vs. 0.603) and state/local appropriations and tuition/fees in \$1000 increments to simplify the interpretation of the regression coefficients. We tested for heteroskedasticity in linear regression models using Breusch-Pagan/Cook-Weisberg tests (Breusch & Pagan, 1979) and used robust standard errors when needed ($p < 0.05$ when testing the null hypothesis that residuals are normally distributed). We conducted all data management and analyses using Stata 17 (StataCorp, 2021).

Results

Overall Distribution of Community College Background and Race/Ethnicity

Figure 1 shows the percentage of graduates in each health profession with a CC background. As shown, the prevalence of CC background among health professions graduates was between 25% and 35%, which is similar to what has been found in studies of other health professions (Talamantes et al., 2014, 2018). Among the four professions, pharmacy graduates were the most likely to have CC backgrounds (34.7%), while dentistry graduates were least likely (24.8%).

Figure 1. Percentage of Graduates with Community College Background (by Profession)

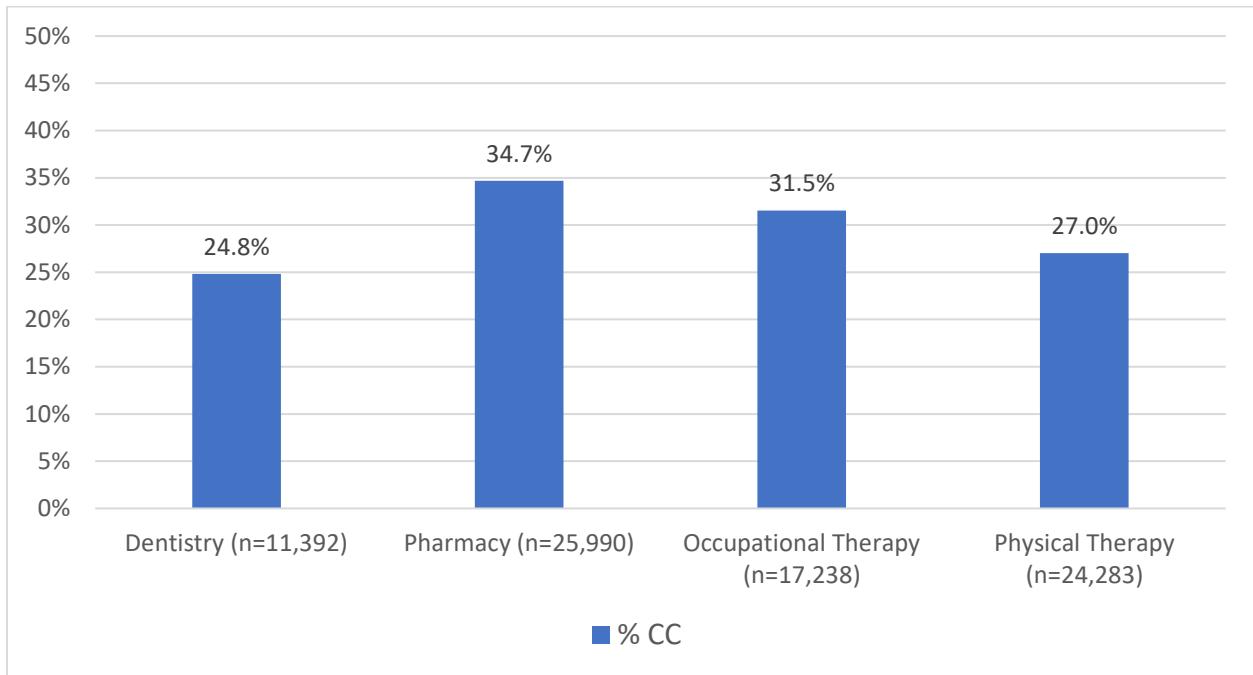
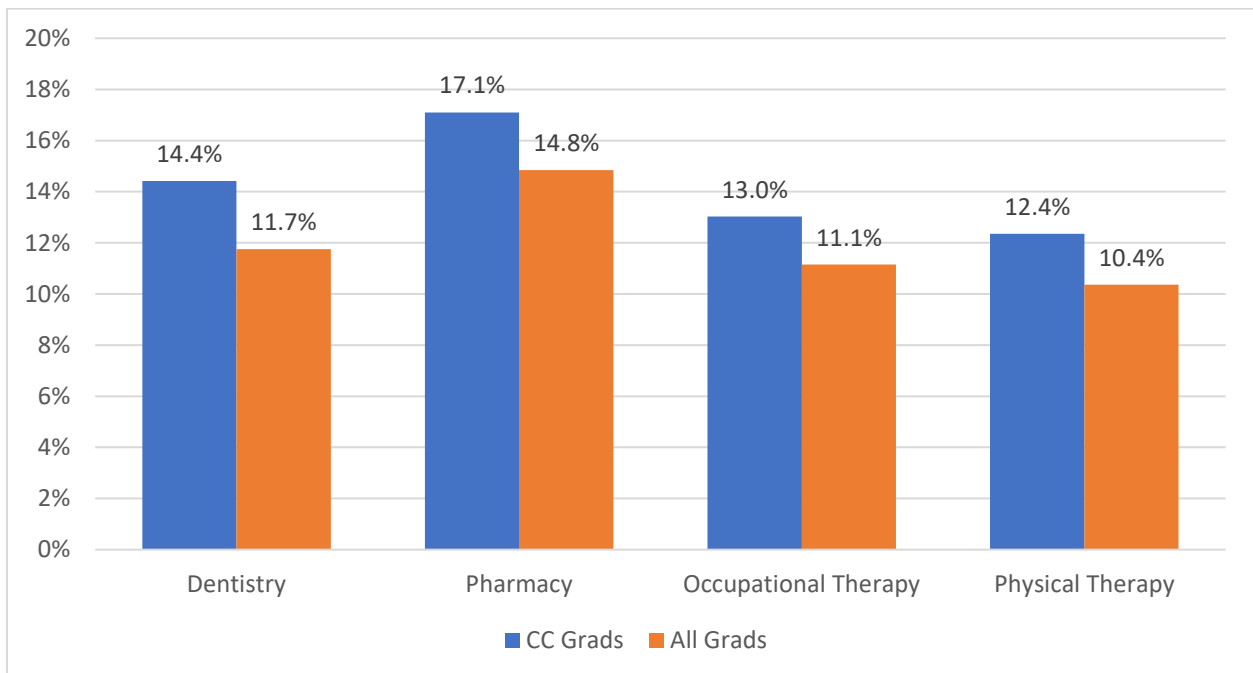


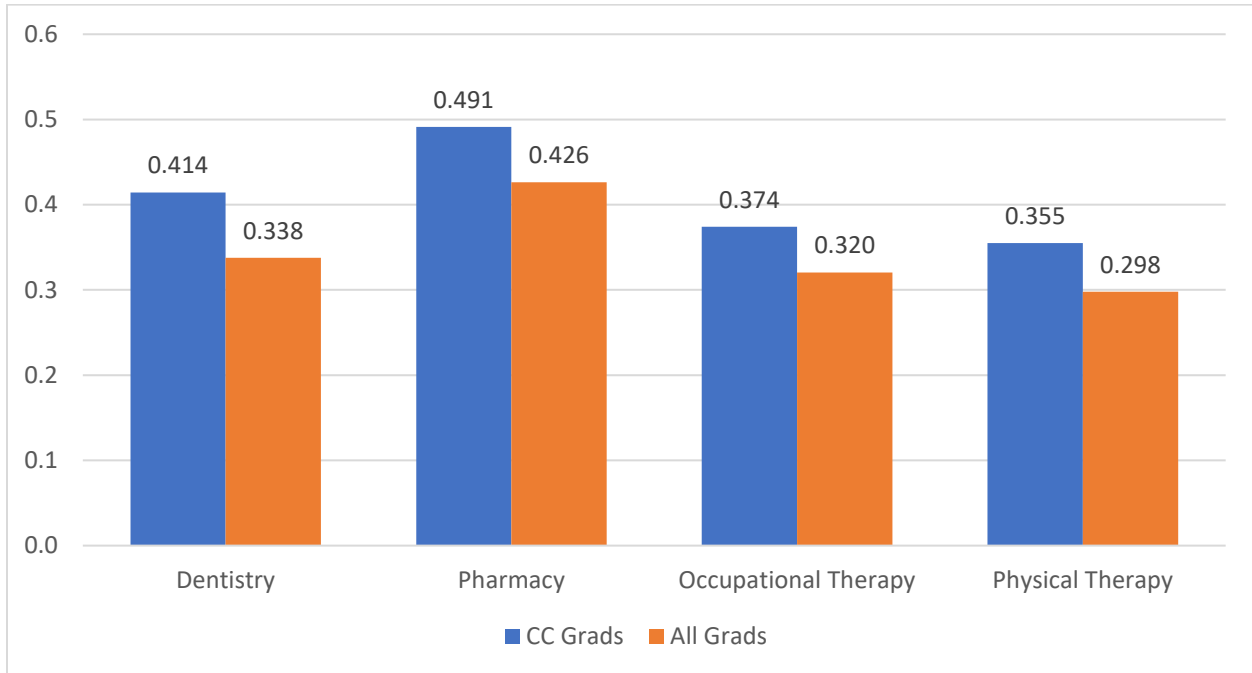
Figure 2 shows the percentage of Black/Hispanic graduates in each profession among CC background graduates and all graduates. When examining the racial/ethnic composition of graduates by profession and CC background, we found that CC background graduates were more likely to be Black and/or Hispanic than all graduates for every profession. For example, pharmacy graduates were most likely to be Black/Hispanic overall (14.8%) and particularly among CC background graduates (17.1%).

Figure 2. Percentage of Black/Hispanic Graduates by Profession (CC Background and All)



As shown in **Figure 3**, the percentages of Black/Hispanic graduates were low relative to the percentage of the U.S. population aged 20-35, that is Black/Hispanic (34.8%). In addition, the diversity indices for graduates in all four professions were less than 0.5 (maximum 0.491 for pharmacy CC background graduates). In other words, pharmacy CC background graduates the group with the highest Black/Hispanic representation are still less than half as likely to be Black/Hispanic relative to the general population ages 20-35.

Figure 3. Black/Hispanic Diversity Index of Graduates by Profession (CC Background and All)



Race/Ethnicity Distribution of Graduates (Community College Background vs. All)

Figure 4 (Appendix A) shows the race/ethnicity breakdown of CC background dentistry graduates (n=2,900) and all dentistry graduates (n=11,392). The comparison shows that Hispanic graduates were overrepresented among CC graduates compared to all graduates (9.1% of CC background graduates but only 5.9% of all graduates). Black graduates were slightly underrepresented (3.7% of CC background graduates vs. 4.1% of all graduates), and white graduates were slightly overrepresented (51.6% of CC background graduates vs. 48.4% of all graduates).

Figure 5 (Appendix A) shows the race/ethnicity breakdown of CC background (n=9,212) and all pharmacy graduates (n=25,990). The comparison shows that Hispanic and Black graduates were slightly overrepresented among CC graduates compared to all graduates: 7.1% of CC background graduates vs. 5.9% of all graduates were Hispanic, and 7.7% of CC background graduates vs. 7.0% of all graduates were Black. Pharmacy graduates (both CC background and all) were less likely than dentistry graduates to be white and more likely to be Black or in the "other" race/ethnicity category (which includes individuals of more than one race, American Indian/Alaska Native, and other smaller categories).

Figure 6 (Appendix A) shows the race/ethnicity breakdown of CC background (n=5480) and all occupational therapy graduates (n=17,238). OT graduates were more likely than dentistry or pharmacy to be white, and the distribution across other categories was mostly consistent between CC background graduates and all graduates. As in dentistry and pharmacy, Hispanic graduates were slightly overrepresented among CC background graduates vs. all graduates (7.7% vs. 6.1%). The percentage of Black graduates with CC backgrounds overall was similar (3.7% vs. 3.6%).

Figure 7 (Appendix A) shows the race/ethnicity breakdown of CC background (n=6599) and all physical therapy graduates (n=24,283). Like occupational therapy, physical therapy graduates were more likely to be white than dentistry or pharmacy graduates and CC background graduates were even more likely to be white than all graduates (65.4% vs. 63.1%). Hispanic graduates were again overrepresented among CC background graduates (8.0% vs. 6.0%), and Black graduates represented similar proportions in each group (2.9% CC and 3.1% all).

Percentage of Graduates with Community College Backgrounds (by Profession & Race/Ethnicity)

Figure 8 (Appendix B) shows the percentage of dentistry graduates with a CC background by race/ethnicity. Among dentistry graduates, Hispanic graduates were most likely to have CC backgrounds they were more than three times as likely as Asian graduates (who had the lowest %) to have started their higher education in a CC (39.5% vs. 11.7%). Black graduates were also more likely to have CC backgrounds than Asian graduates. However, their rate was more similar to other race/ethnicity groups and slightly lower than white graduates (22.9% vs. 27.1%).

Figure 9 (Appendix B) shows the percentage of pharmacy graduates with CC background by race/ethnicity. Among pharmacy graduates, Hispanic (42.8%) and Black (39.3%) were most likely to have CC backgrounds. However, the differences between race/ethnicity groups were less stark for pharmacy than for dentistry. For example, even among Asian graduates (the least likely group to have a CC background), nearly one-third (31.8%) of pharmacy graduates started their higher education in a CC.

Figure 10 (Appendix B) shows the percentage of occupational therapy graduates with CC background by race/ethnicity. Again, Hispanic graduates (39.8%) were most likely to have CC backgrounds, and Black graduates were also more likely than average (32.5%) to have CC backgrounds. Like pharmacy, the differences between race/ethnicity groups' likelihood of CC background were smaller, with almost one-fourth of Asian graduates (the least likely group) having a CC background.

Figure 11 (Appendix B) shows the percentage of physical therapy graduates with CC background by race/ethnicity. While the overall percentages were smaller, Hispanic graduates again had the highest likelihood of having a CC background (36.4%). Black graduates were slightly less likely to have CC backgrounds than graduates overall (26.0% vs. 27.0%), and Asian graduates (as was the case in dentistry) had a much smaller percentage of CC background graduates (7.0%).

Percentage of Graduates with Community College Background (by Profession & State)

Figure 12 (Appendix C) shows the percentage of dentistry graduates with CC backgrounds by state. As shown, the percentage of dentistry graduates with CC backgrounds varied widely by state, from nearly half (48.0%) in Texas to fewer than 10% in Connecticut. As shown in **Figure 13**, the percentage of pharmacy graduates with CC backgrounds by state was generally higher but has an even wider range than for dentistry graduates. Eleven states (led by Wyoming [61.7%]) had more than 50% of pharmacy graduates with CC backgrounds, while Rhode Island had the smallest percentage with just over 10%.

As shown in **Figures 14 and 15**, (Appendix C) the therapy professions (occupational and physical) had even wider variation in the percentage of graduates with CC backgrounds by state. For example, Mississippi had the highest percentage of CC background graduates for both therapy professions (86.7% OT and 67.0% PT). Meanwhile, the states with the smallest percentages had around 10% CC background for both professions.

Percentage of Black/Hispanic Community College Background Dentistry Graduates (by Profession & State)

Figure 16 (Appendix D) shows that the percentage of Black/Hispanic CC background dentistry graduates varied significantly by state, from 100% (Connecticut) to 0% (Minnesota and West Virginia). However, these findings should be interpreted with caution because dentistry had the smallest overall number of graduates and the smallest percentage of CC background graduates, meaning that some states had very small numbers of CC background dentistry graduates.

As shown in **Figure 17** (Appendix D), the District of Columbia had the highest percentage of Black/Hispanic CC background pharmacy graduates (83.9%), followed by New Mexico (50.9%) and Maryland (47.9%). While some states had small percentages of Black/Hispanic CC background graduates, no state had 0%, which was not the case for other professions.

As shown in **Figures 18 and 19** (Appendix D), New Mexico and the District of Columbia also had the highest percentage of Black/Hispanic CC background occupational therapy and physical therapy graduates, although the percentages were lower than the dentistry and pharmacy. New Mexico was the only state with over half Black/Hispanic CC background graduates for occupational therapy (52.3%) and physical therapy (66.7%).

Black/Hispanic Diversity Index of Community College Background Graduates (by Profession & State)

Figure 20 (Appendix D) shows the diversity index comparing the percentage of Black/Hispanic CC background dentistry graduates to each state's population aged 20-35. The diversity indices ranged from 3.44 (Maine) to 0 (Minnesota and West Virginia). Besides Maine, four other states (Connecticut, the District of Columbia, Tennessee, and Utah) had diversity indices greater than 1, meaning their CC background dentistry graduates were more likely to be Black/Hispanic than the state population aged 20-35. However, ten states had diversity indices of 0.25 or less, meaning their CC background dentistry graduates were less than ¼ as likely to be Black/Hispanic as the population.

As shown in **Figure 21** (Appendix D), Maine also had the highest Black/Hispanic diversity index (8.42) for CC background pharmacy graduates – the highest of any profession and state in the entire analysis. Seven other states also had diversity indices greater than 1, meaning their CC background pharmacy graduates were at least as likely as their population aged 20-35 to be Black and/or Hispanic. No states had a diversity index of zero for pharmacy graduates, but graduates in the states with the lowest indices (New York, Rhode Island, and California) were about 1/5 as likely to be Black/Hispanic relative to the population.

As shown in **Figure 22** (Appendix D), the diversity index range across states was narrower for occupational therapy – from 1.91 in Maine to 0 in several states. Only Maine and the District of Columbia had indices greater than 1, indicating that their CC background occupational therapy graduates were more likely to be Black/Hispanic than the population.

As shown in **Figure 23** (Appendix D), the range of Black/Hispanic diversity indices of CC background physical therapy graduates was also narrower than for dentistry and pharmacy, from 2.13 in Maine to 0 in several states. Besides Maine, four other states (New Hampshire, West Virginia, New Mexico, and Montana) also had Black/Hispanic diversity indices greater than 1.

Regression Analyses

Percentage of Graduates with Community College Background vs. State-Level Community College Availability/Enrollment, Funding & Cost

Simple and multiple regression results for the models examining state-level factors associated with the percentage of health professions graduates with CC backgrounds appear in **Tables 1-4** (Appendix F).

The analyses showed a consistent pattern across all four professions: state-level CC FTEs per 1,000 population are significantly and positively associated with the percentage of health professions graduates in a state who have a CC background ($p < 0.05$ for all professions and models). The association is present in simple regression models for all four professions and remains after controlling for CC funding (measured as state appropriations or state and local appropriations per CC FTE [in thousands]). In other words, states with higher CC availability per population also have a higher percentage of health professions graduates with CC backgrounds, even when controlling for CC funding per FTE and average tuition and fees.

In the multiple regression models, the magnitude of the association ranges from 0.88 ($p < 0.05$) for dentistry (with funding measured as state appropriations) to 1.53 for pharmacy (with funding also measured as state appropriations). Therefore, these coefficients can be interpreted as follows: each additional CC FTE per 1000 in a state is associated with an 0.88 to 1.53 percentage point increase in the percentage of health professions graduates with CC background in that state, holding state appropriations to CCs and CC tuition/fees constant.

The other variables state or state & local appropriations to CCs and CC tuition & fees were not associated with the percentage of health professions graduates with CC backgrounds in any linear regression models.

Percentage of Black/Hispanic Community College Background Graduates vs. State-Level Community College Availability/Enrollment, Funding & Cost

Simple and multiple regression results for the models examining state-level factors associated with percentage of health professions graduates with CC backgrounds appear in **Tables 5-8** (Appendix G).

The models for the four professions were less consistent with each other than with the overall CC background models described above. Still, a few key factors emerged: CC availability/enrollment was significantly and positively associated with the percentage of Black/Hispanic CC background graduates for occupational and physical therapy. These associations remained after controlling for state or state/local CC appropriations and CC tuition & fees. The multiple regression model coefficients can be interpreted as follows: for example, each additional CC FTE per 1000 in a state is associated with a 1.17 percentage point increase in the percentage of OT CC background graduates in that state who are Black and/or Hispanic, holding state appropriations to CCs and CC tuition/fees constant.

The models for dentistry only also suggested a positive and significant association between state appropriations per CC FTE and percentage of Black/Hispanic CC background graduates, which also held up in the multiple regression model holding CC FTEs per population and tuition/fees constant. The multiple

regression coefficient can be interpreted as follows: a \$1,000 increase in state appropriations per CC FTE is associated with a 6.27 percentage point increase in the percentage of dentistry graduates with CC backgrounds who are Black and/or Hispanic holding CC FTEs per population and tuition/fees constant. This association was not present for any other professions, and we found no significant associations between CC tuition and fees and the percentage of Black/Hispanic CC background graduates for any of the professions.

Black/Hispanic Diversity Index of Community College Background Graduates vs. State-Level Community College Availability/Enrollment, Funding & Cost

Simple and multiple regression results for the models examining state-level CC variables associated with the Black/Hispanic diversity index of health professions graduates with CC backgrounds appear in **Tables 9 through 12** (Appendix H).

The only variable significantly associated with the Black/Hispanic diversity index was state appropriations per FTE, which was positively associated with the diversity index for dentistry and physical therapy CC graduates. (The association approached statistical significance for the simple regression of diversity index of dentistry graduates vs. state appropriations per FTE [$p=0.053$] and was significant [$p<0.05$] for all other models for the two professions.) The multiple regression coefficients can be interpreted as follows (for example): a \$1,000 increase in state appropriations per CC FTE is associated with an 0.26 unit increase in the Black/Hispanic diversity index of its CC background dentistry graduates, holding CC FTEs per population and tuition/fees constant. These findings suggest that states with higher CC appropriations have more Black/Hispanic representation vs. population among their dentistry and physical therapy graduates, even after accounting for CC availability and costs.

We found no significant associations between CC FTEs per population, tuition and fees, or the Black/Hispanic diversity index of CC background graduates for any professions.

Discussion

When examining the race/ethnicity composition of CC background graduates compared with all graduates, the distributions mostly mirror each other suggesting that the populations reaching dentistry, pharmacy, OT, and PT programs through CCs and other pathways are generally similar. Health professions graduates with CC backgrounds are more likely to be Black or Hispanic than all graduates in all four professions. However, the overall numbers are small, and CC background graduates are still not fully representative of the total population. CC background health professions graduates have a higher Black/Hispanic diversity index than all graduates in all professions examined in this study. However, it is still less than 0.5 for all professions. In other words, even CC background health professions graduates are less than half as likely to be Black and/or Hispanic than the U.S. population aged 20-35. While some states have high diversity indices, although denominators for some states are very small.

Health professions graduates from racial/ethnic minority groups (especially Hispanic graduates) are more likely to have CC backgrounds, but the overall numbers are small. Around 40% of Hispanic graduates had CC backgrounds in dentistry, pharmacy, and OT, and Hispanic graduates were overrepresented in the CC background group relative to all graduates for all four professions. This finding suggests that for Hispanic students, in particular, CCs can be a critical first stop on their journey into health professions careers (Gonzalez & Hilmer, 2006). The findings were less consistent for Black graduates across professions, although they had a high percentage of CC background graduates in pharmacy.

In our studies of state-level CC indicators and diversity of health professions graduates, we found that higher state-level CC FTEs per population was consistently associated with a greater percentage of health professions graduates with CC background. This association was evident across all four professions and remained when accounting for state or state/local funding and tuition/fees. This finding is not surprising it suggests that states with more CC availability have greater representation of CC background graduates in health professions, likely because more students had opportunities to study at CCs before pursuing advanced degrees. Findings were less consistent when examining associations between state-level CC availability, funding and costs and measures of health professions diversity. CC availability/enrollment was significantly and positively associated with the percentage of Black/Hispanic graduates for occupational therapy and physical therapy, and state appropriations per CC FTE were associated with some state-level diversity metrics (percentage of Black/Hispanic CC background dentistry graduates and Black/Hispanic diversity index for CC background dentistry and physical therapy graduates).

Costs of CC education (average tuition and fees) were not associated with CC background graduate diversity metrics for any health profession in any model. In other words, we did not find support for the hypothesis that lower costs of CC education mean more diversity among CC background health professions graduates, at least not for the health professions we examined. While it is likely that lower costs could enable more underrepresented students to enter CCs, perhaps increased access to CC education does not translate into higher levels of participation in health professions education. This could be due to high costs of attending health professions programs (Brent, 2021) as well as other systemic challenges to minority students' completion of health professions education: lack of diverse faculty, limited mentorship, and a lower sense of belonging (Dickson & Zafereo, 2021; Ford et al., 2021; Strayhorn, 2020). Evidence from the physical therapy field also suggests that competition between programs for minority students and faculty can negatively impact the field's diversity (Dickson & Zafereo, 2021). All health professions examined in this study have efforts underway (Grajo et al., 2018; Matthews et al., 2021; Nalliah et al., 2021; Wall et al., 2015) to increase diversity in their recruitment and retention of minority students in their degree programs. However, it takes time to build up the critical mass of diverse faculty role models to make a quantifiable difference in the diversity of graduates (Dickson & Zafereo, 2021). The role of CCs in diversifying the pipeline is important for some professions and subgroups. Still, the association between state-level measures of CC access and the diversity of health professions graduates with CC backgrounds is complex.

Limitations

This study has several limitations. First, the NSC health professions graduate datasets only included aggregated numbers by categories identified by NSC analysts we did not work directly with the individual student-level data. NSC rules require specific numbers in categories with 1 to 9 individuals to be masked, so we had to calculate ranges or use other methods to estimate some measures included in the descriptive data and modeling. The NSC data also had high numbers of "other" and "unknown" race/ethnicity categories for some professions and states, which may have affected the estimates. The quality of the NSC's race/ethnicity data has improved significantly in the past several years (Dundar & Shapiro, 2016), but since student data is self-reported, there is always some uncertainty, and data are never quite complete.

Second, measuring health professions graduates' CC exposure by "first enrollment" likely underestimates the full role of CCs in preparing students to enter health professions. The NSC dataset does not include

students who take classes at CCs during or after programs at other institutions. If these students are systematically more or less likely to be Black/Hispanic from "first enrollment" CC students, the study's findings could be different (Luo et al., 2022). The analysis also looks only at students who completed health professions programs, so it does not offer direct insights into what happened to CC students who didn't get into health professions programs or what factors contributed to their outcomes (Cornelison et al., 2022).

Also, the focus of this study on racial/ethnic diversity of health professions graduates may mask the contributions of CCs to other forms of diversity that are more difficult to measure using the NSC data. CCs may increase socioeconomic diversity by giving opportunities to more students with low socioeconomic status or students from rural areas, which could facilitate their later entry into health professions (The Sullivan Commission, 2003).

Finally, the analyses relating state-level CC availability, funding, and costs to racial/ethnic diversity of CC background graduates are somewhat speculative since there are likely many factors besides these that contribute to students' pursuit of health careers. We also don't know exactly when students who completed health professions graduate programs had their CC exposure – it is possible that some studied at CCs outside the period we examined CC data (2010–most recent). Also, health professions graduates do not necessarily complete their subsequent education in the same state where they started, meaning that the composition of a graduating health professions cohort in a state might be different from that of students who began their education (and presumably had their educational pathways shaped by CC availability, funding, and cost) in that state. While we had information on this in the NSC dataset, the state-level numbers (especially for specific race/ethnicity groups) were sometimes too small to be reported directly. From our national analysis of NSC data by profession, the range of CC graduates who started and finished in the same state ranged from 54% (dentistry) to 69% (pharmacy).

Conclusion

The U.S. population is growing more diverse every year, and health professional leaders are eager to increase the presence of underrepresented minority students in their training pipelines. The findings of this study suggest that CCs may contribute to modest increases in the number of Black and Hispanic graduates of dentistry, pharmacy, occupational therapy, and physical therapy programs. The overall numbers of Black and Hispanic health professions graduates are still small and vary widely by profession and state. State-level availability/enrollment and funding of CCs are associated with increased representation of Black and Hispanic graduates for some professions. This suggests that more investments by states in CCs can help more minority graduates who start their education there to reach health professions careers that require advanced degrees.

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APPENDIX A. Race/Ethnicity Distribution of Graduates by Profession (Community College Background vs. All)

Figure 4. Dentistry Graduates Race/Ethnicity Breakdown (CC Background vs. All)

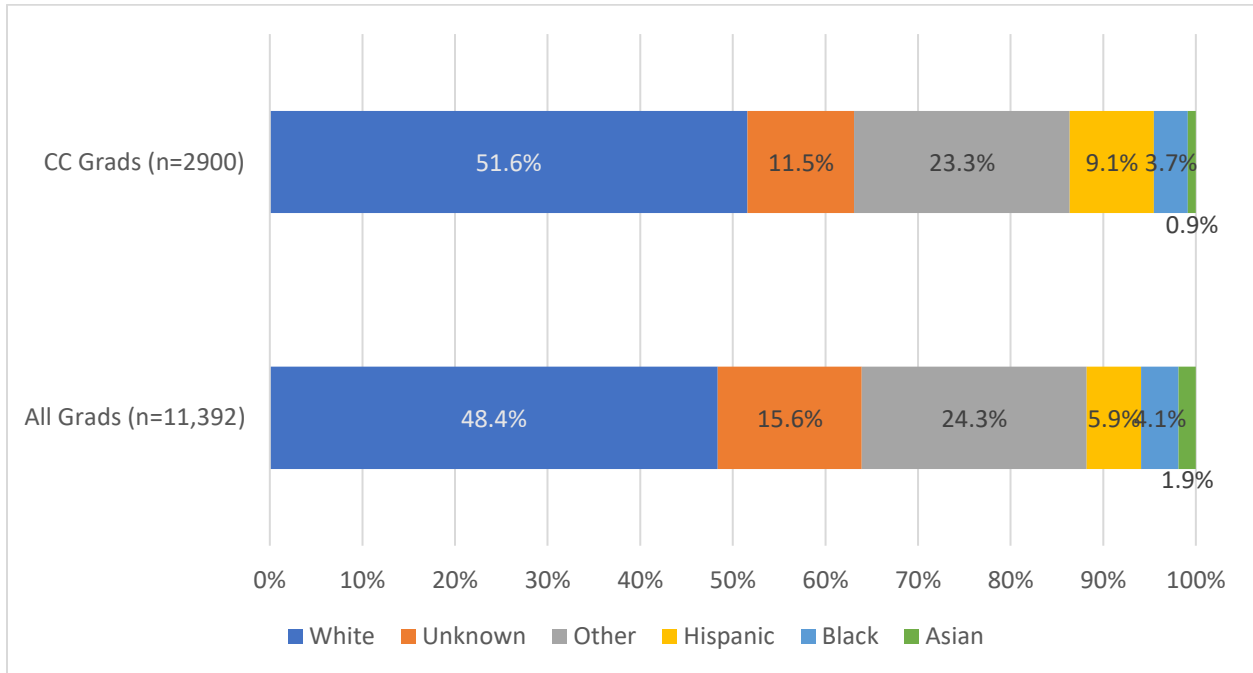


Figure 5. Pharmacy Graduates Race/Ethnicity Breakdown (CC Background vs. All)

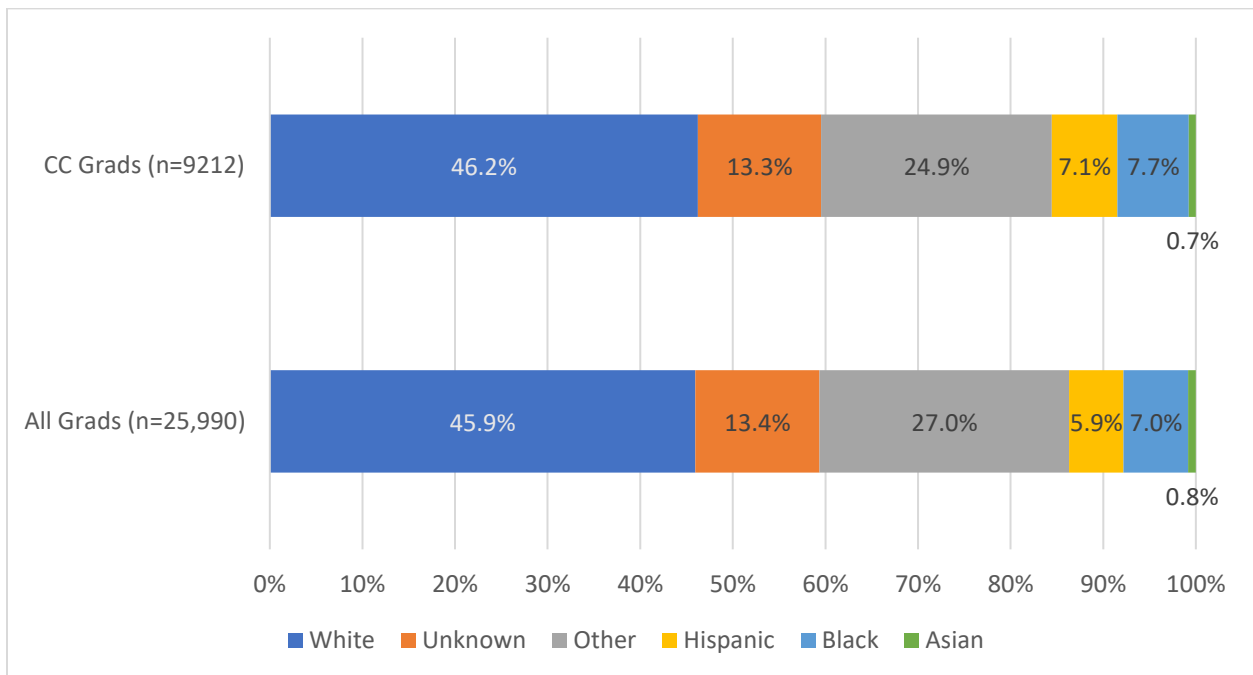


Figure 6. Occupational Therapy Graduates Race/Ethnicity Breakdown (CC Background vs. All)

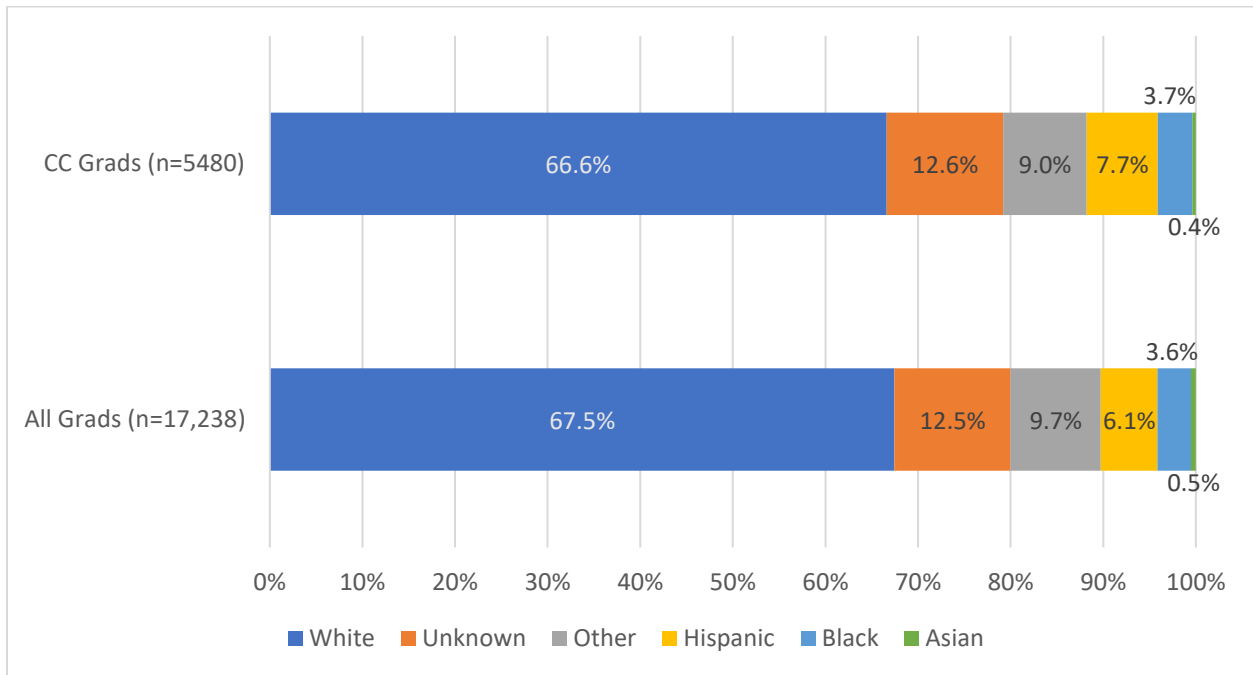
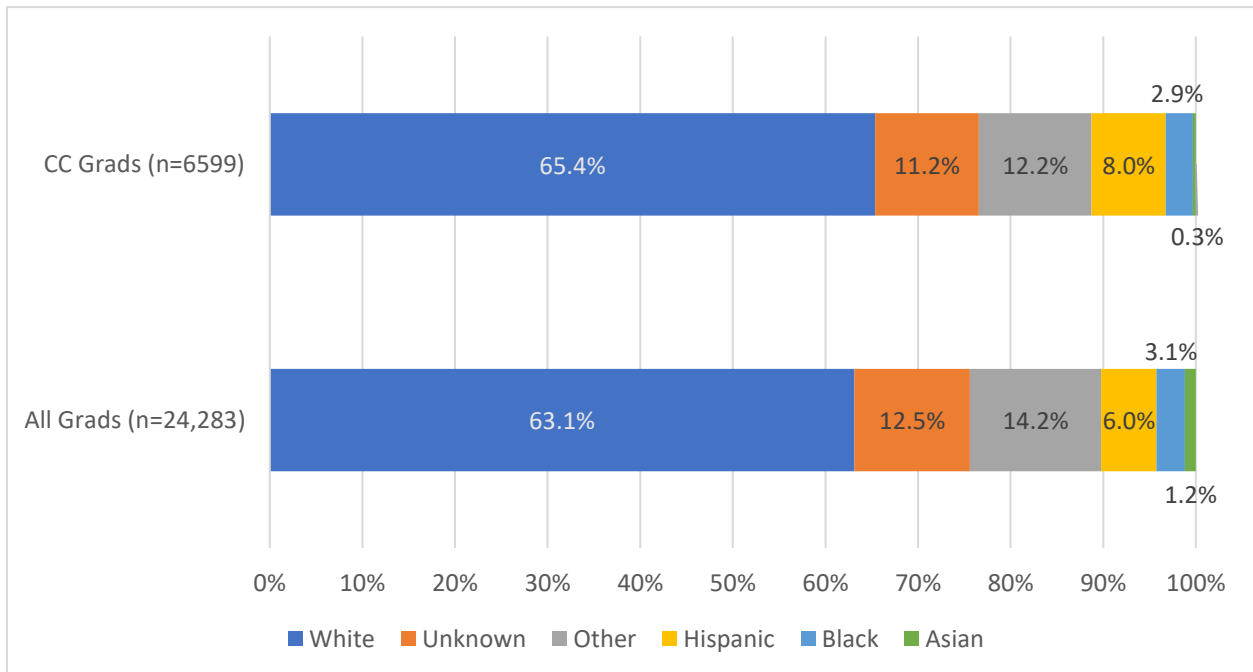


Figure 7. Physical Therapy Graduates Race/Ethnicity Breakdown (CC Background vs. All)



APPENDIX B. Percentage of Graduates with Community College Backgrounds (by Profession & Race/Ethnicity)

Figure 8. Percentage of Dentistry Graduates with Community College Background (by race/ethnicity)

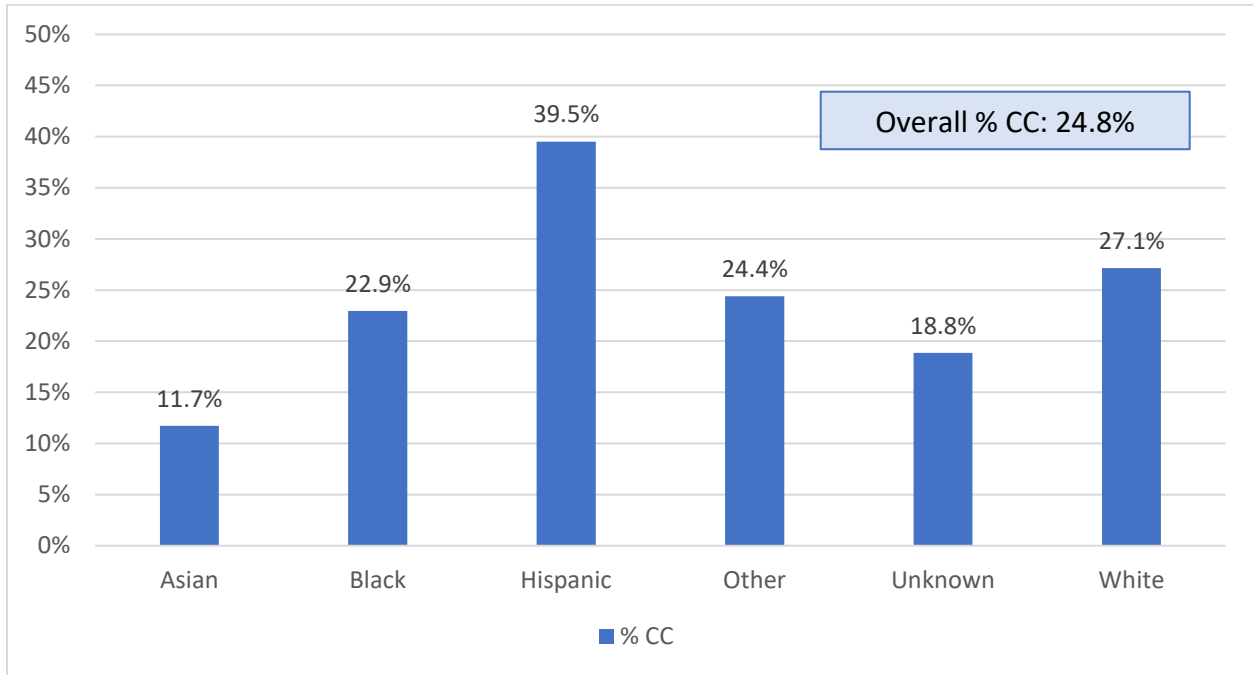


Figure 9. Percentage of Pharmacy Graduates with Community College Background by Race/Ethnicity

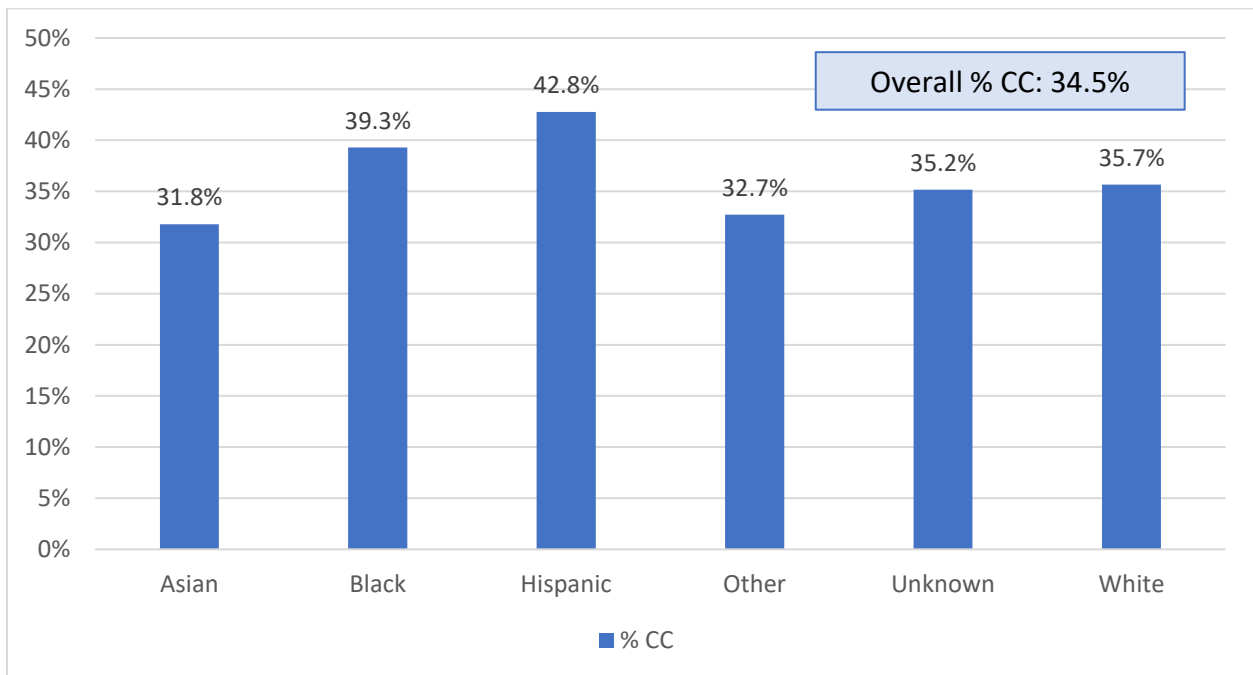


Figure 10. Percentage of Occupational Therapy Graduates with Community College Background by Race/Ethnicity

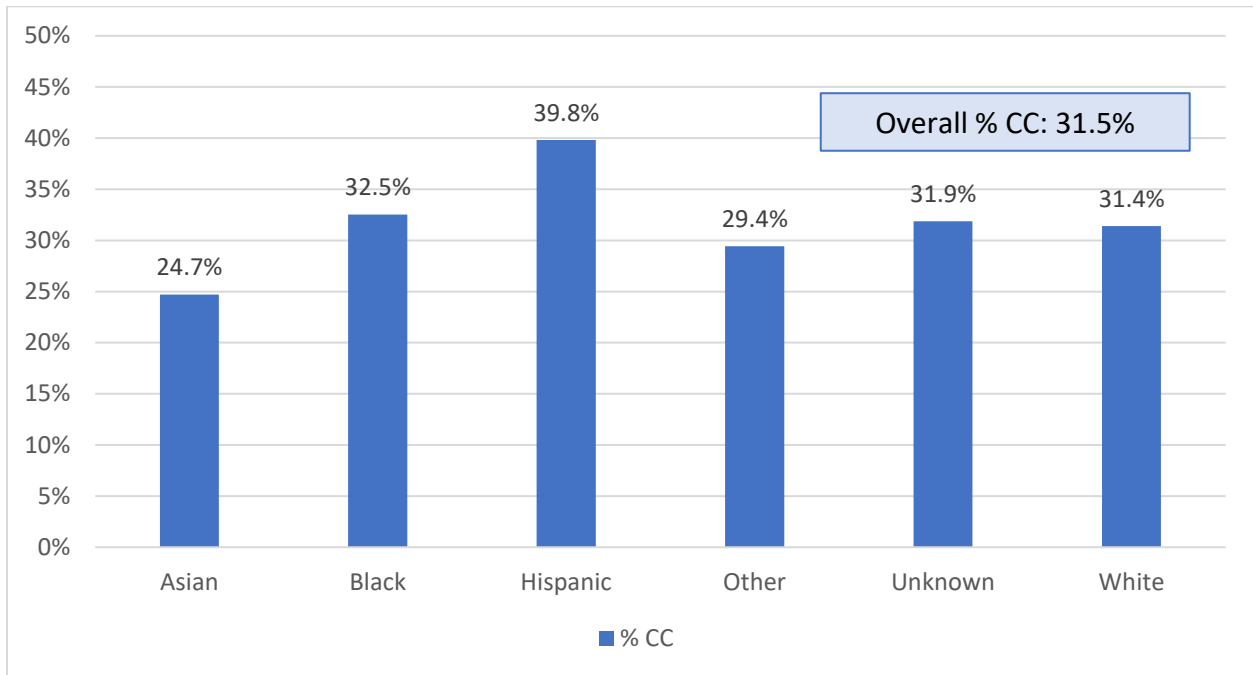
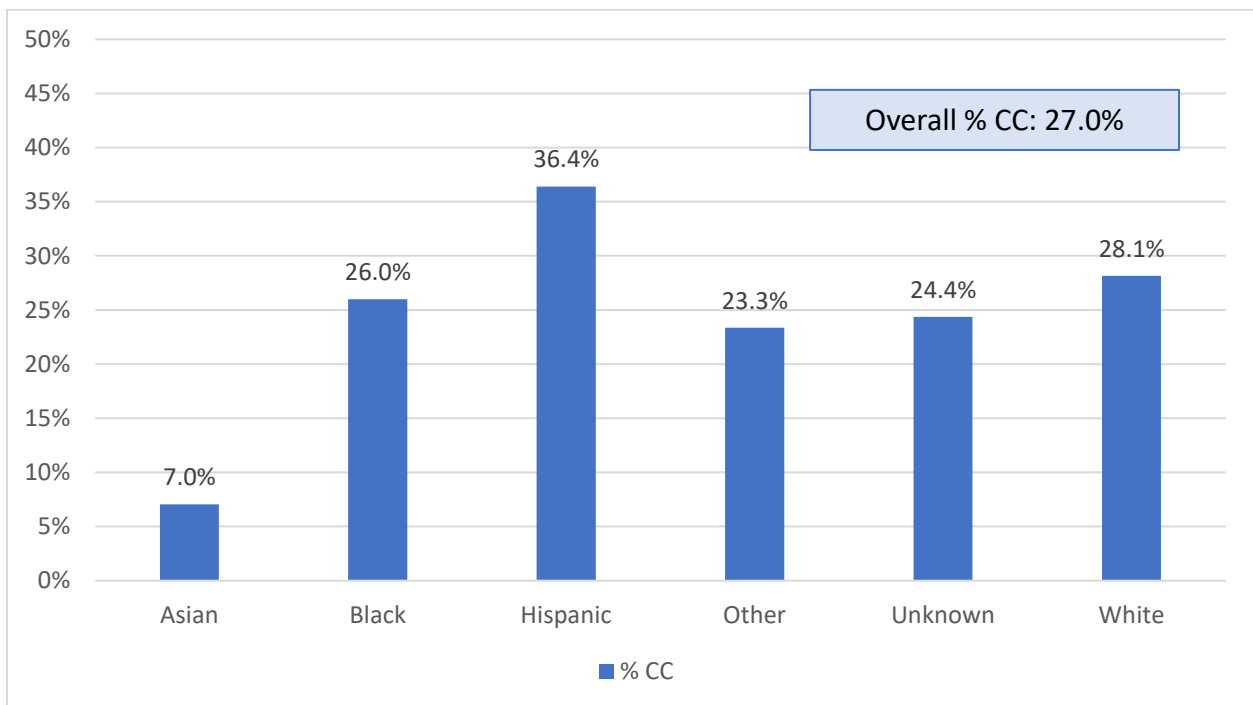


Figure 11. Percentage of Physical Therapy Graduates with Community College Background by Race/Ethnicity



APPENDIX C. Percentage of Graduates with Community College Background (by Profession & State)

Figure 12. Percentage of Dentistry Graduates with Community College Background by State

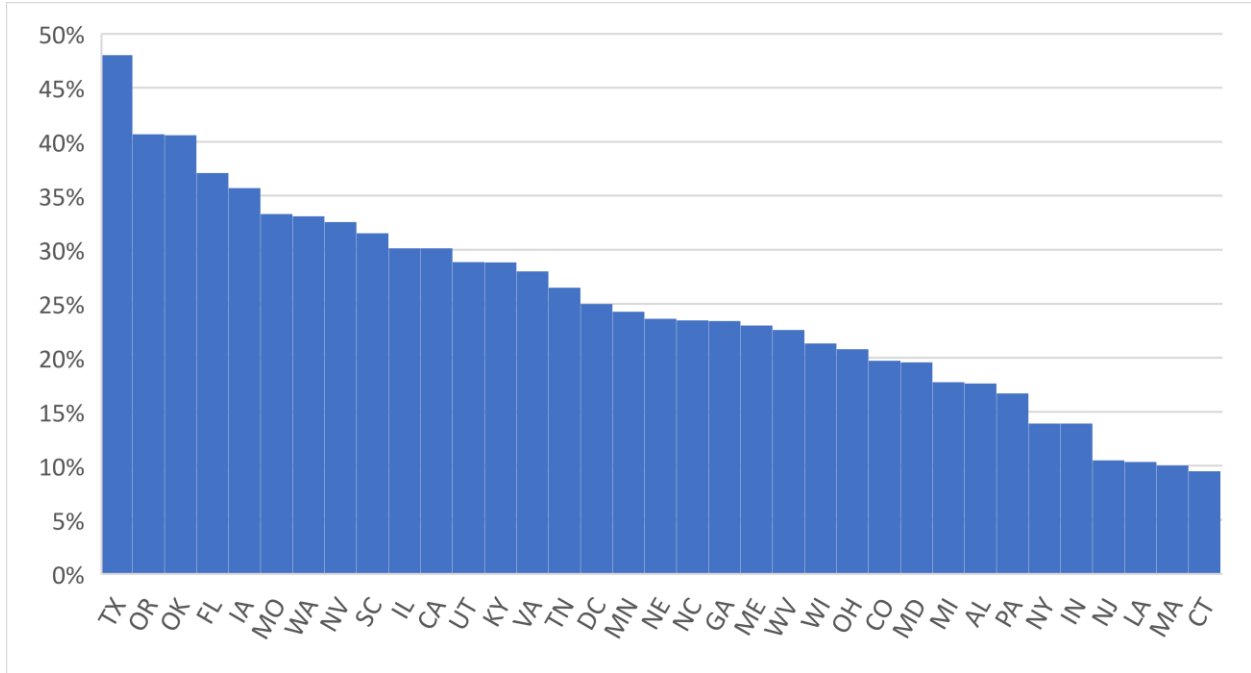


Figure 13. Percentage of Pharmacy Graduates with Community College Background by State

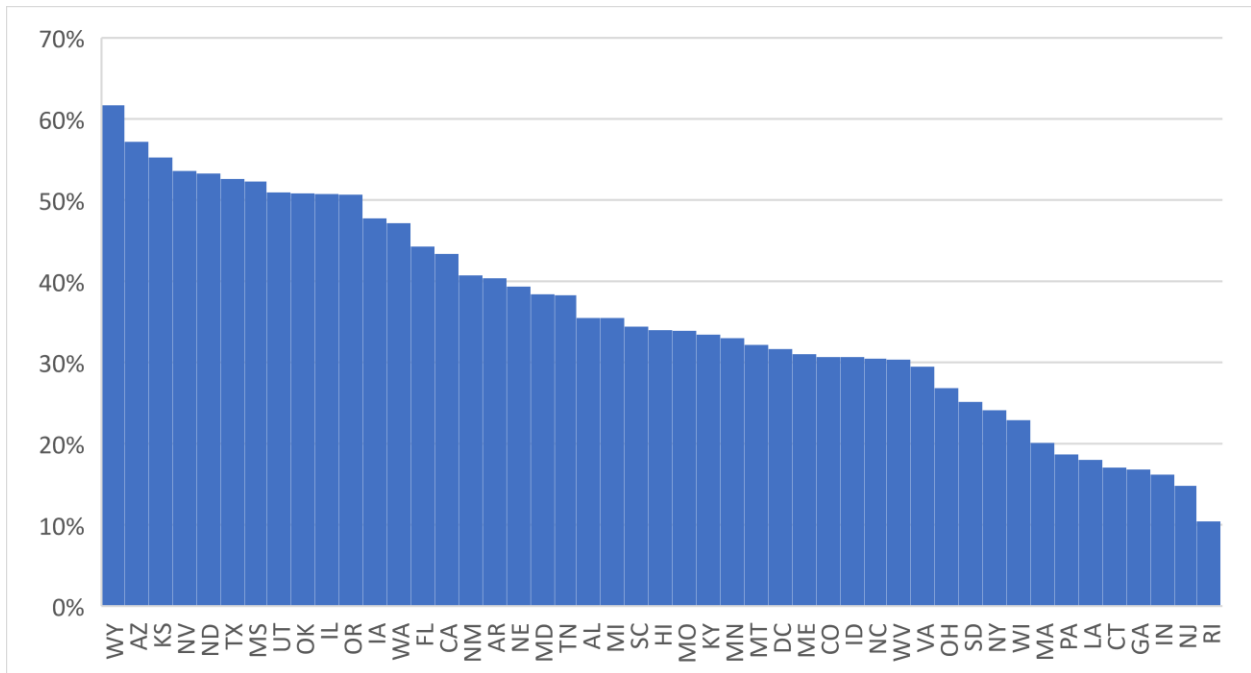


Figure 14. Percentage of Occupational Therapy Graduates with Community College Background by State

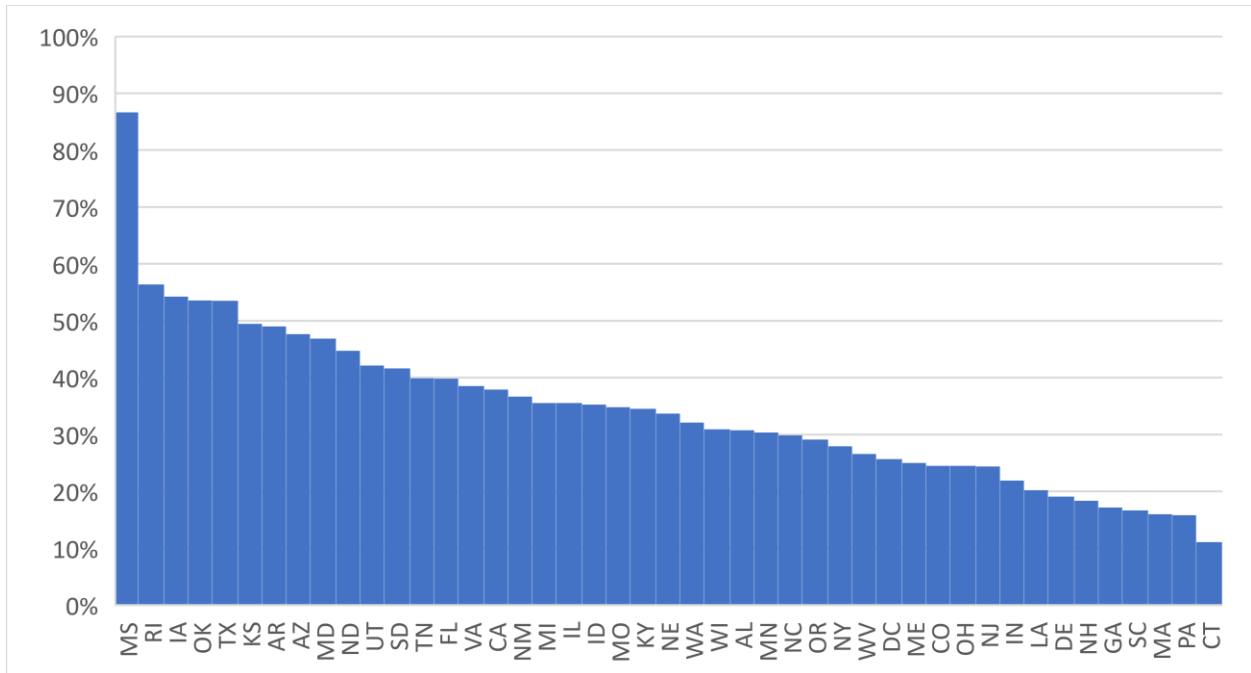
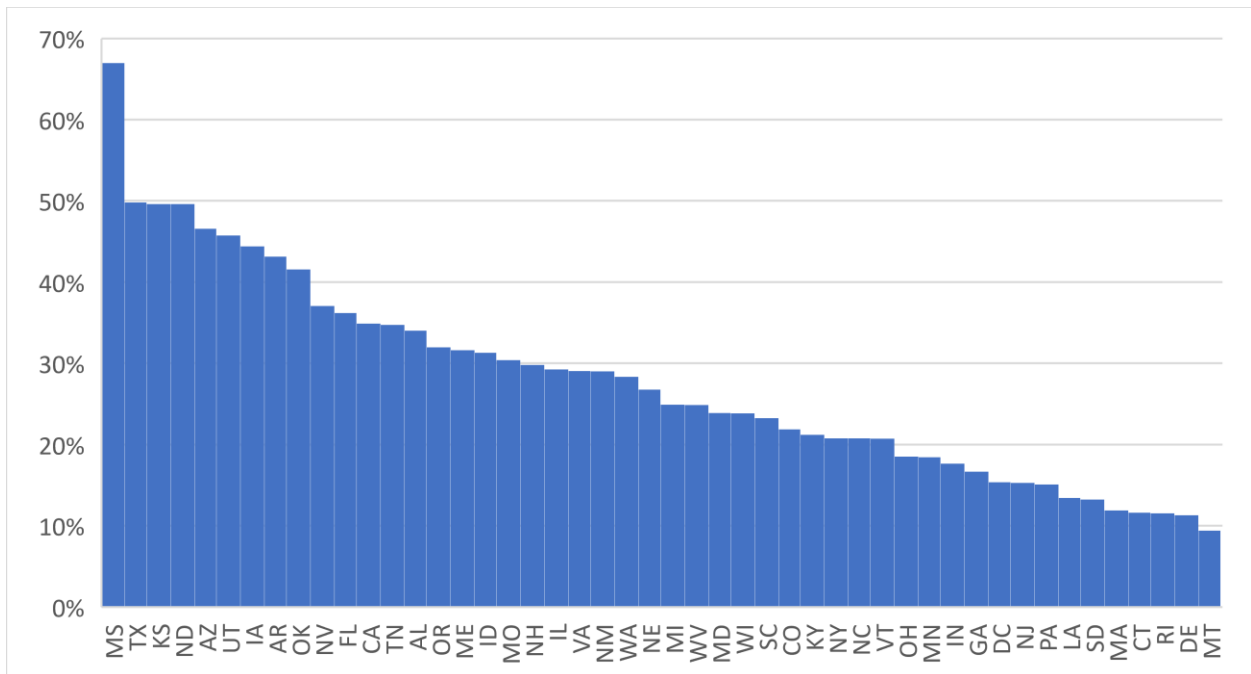


Figure 15. Percentage of Physical Therapy Graduates with Community College Background by State



APPENDIX D. Percentage of Black/Hispanic Community College Background Dentistry Graduates (by Profession & State)

Figure 16. Percentage of Black/Hispanic Community College Background Dentistry Graduates by State

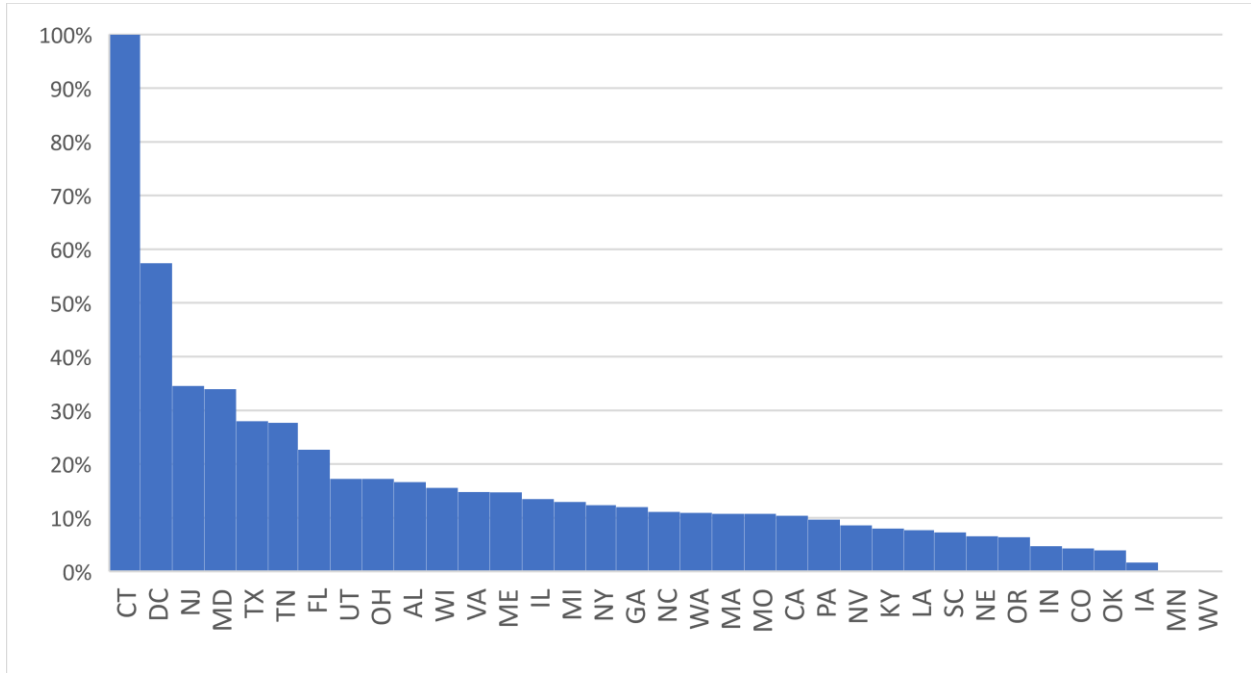


Figure 17. Percentage of Black/Hispanic Community College Background Pharmacy Graduates by State

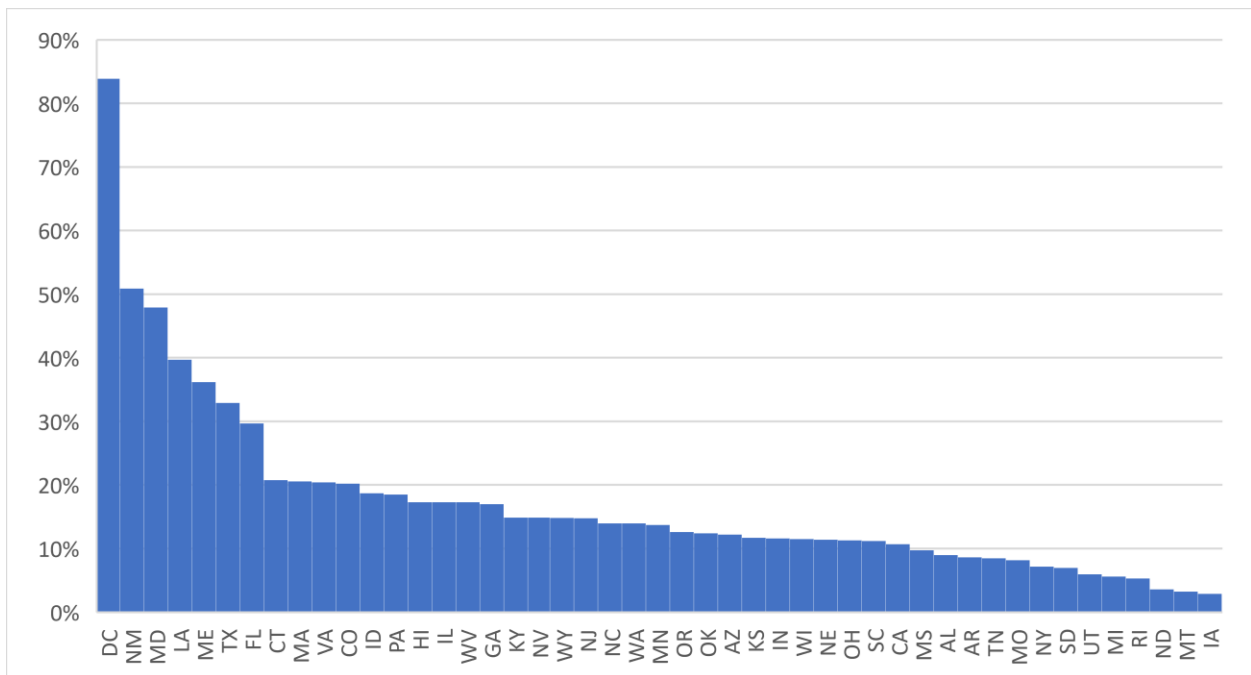


Figure 18. Percentage of Black/Hispanic Community College Background Occupational Therapy Graduates by State

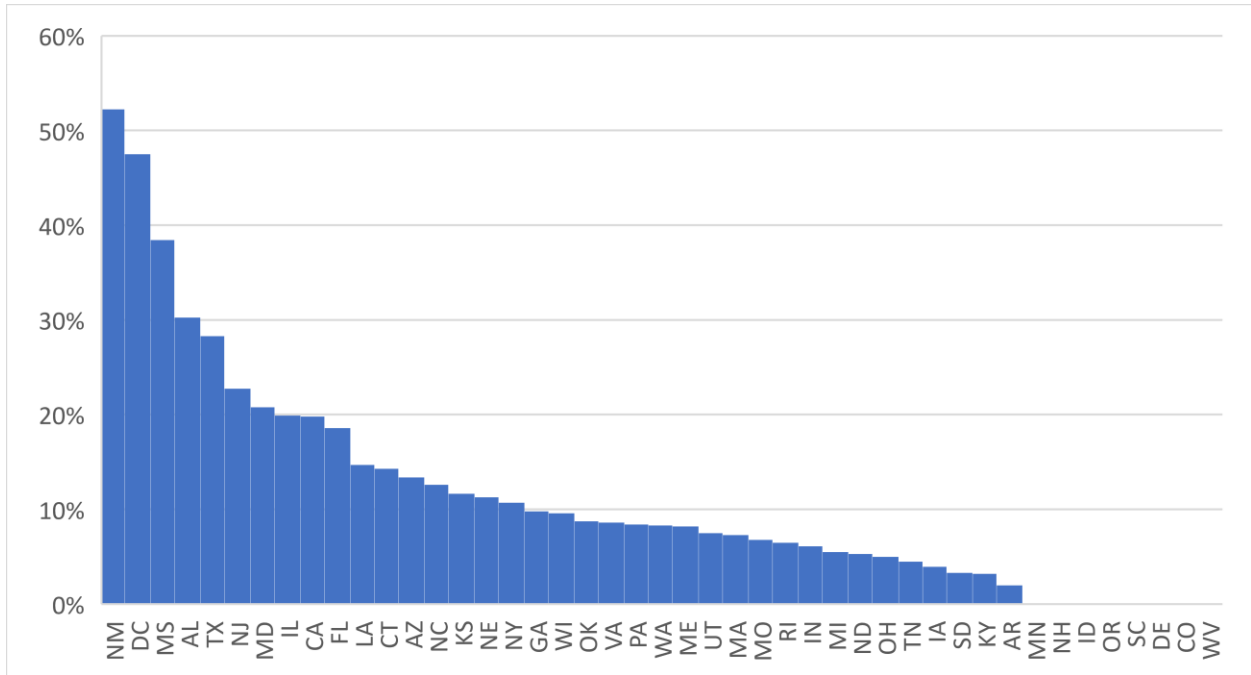
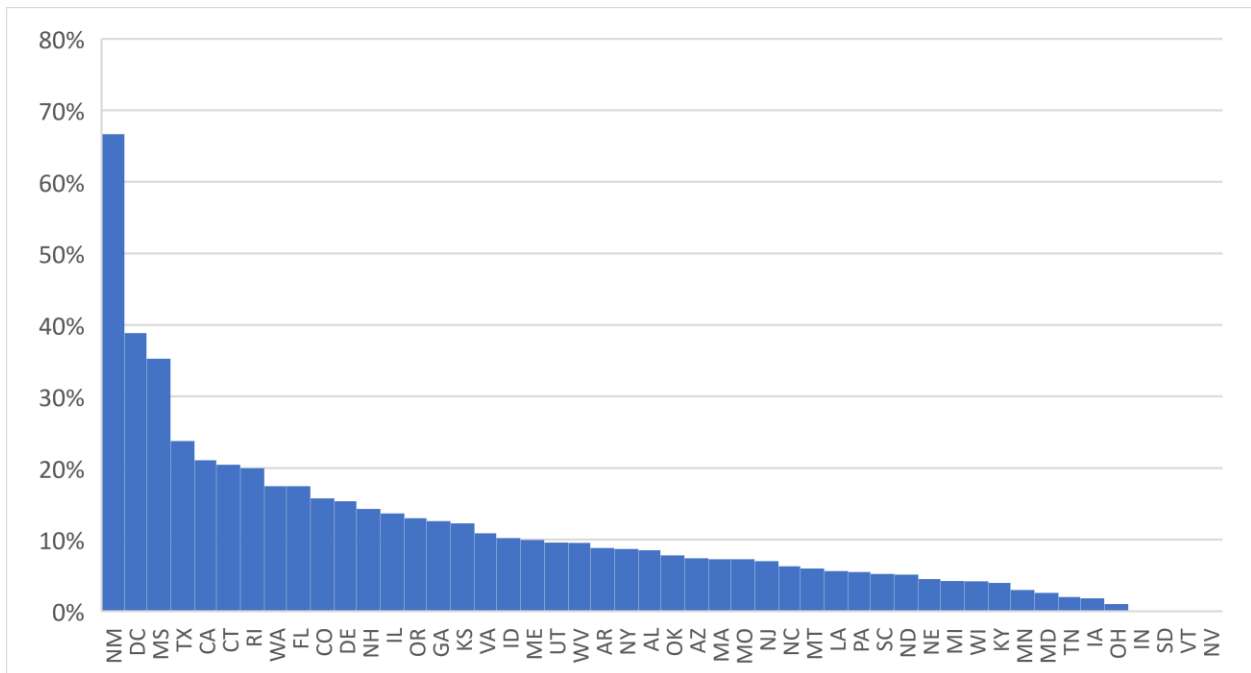


Figure 19. Percentage of Black/Hispanic Community College Background Physical Therapy Graduates by State



APPENDIX E. Black/Hispanic Diversity Index of Community College Background Graduates (by Profession & State)

Figure 20. Black/Hispanic Diversity Index of Community College Background Dentistry Graduates by State

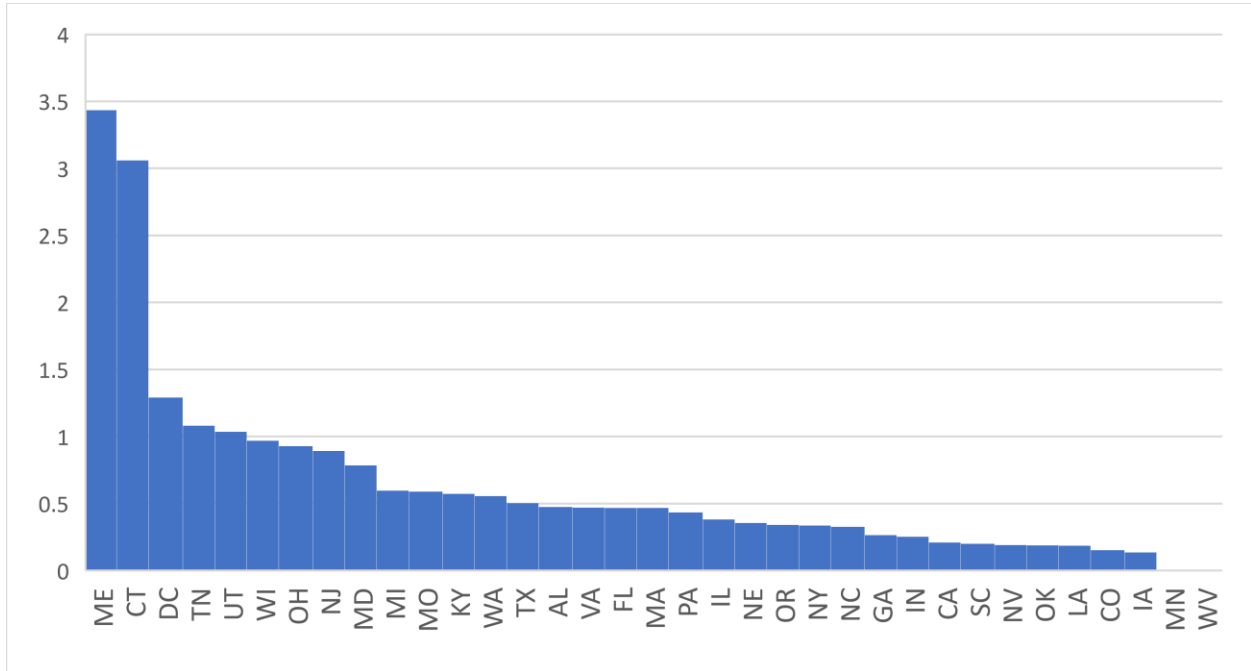


Figure 21. Black/Hispanic Diversity Index of Community College Background Pharmacy Graduates by State

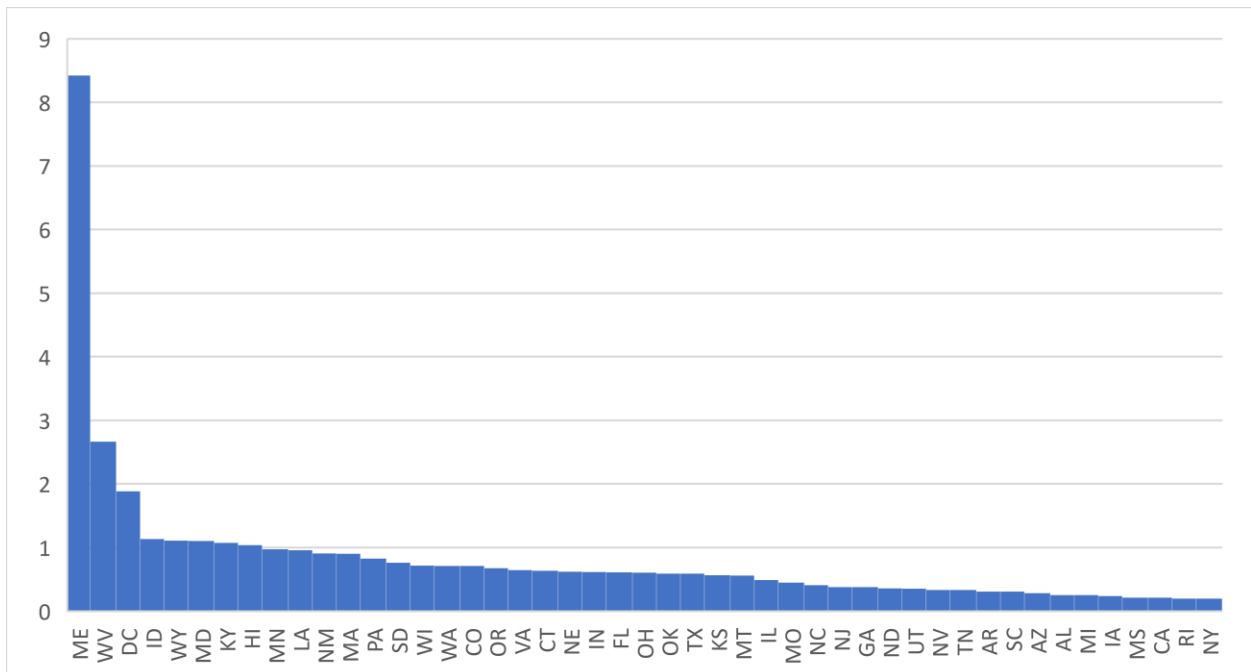


Figure 22. Black/Hispanic Diversity Index of Community College Background Occupational Therapy Graduates by State

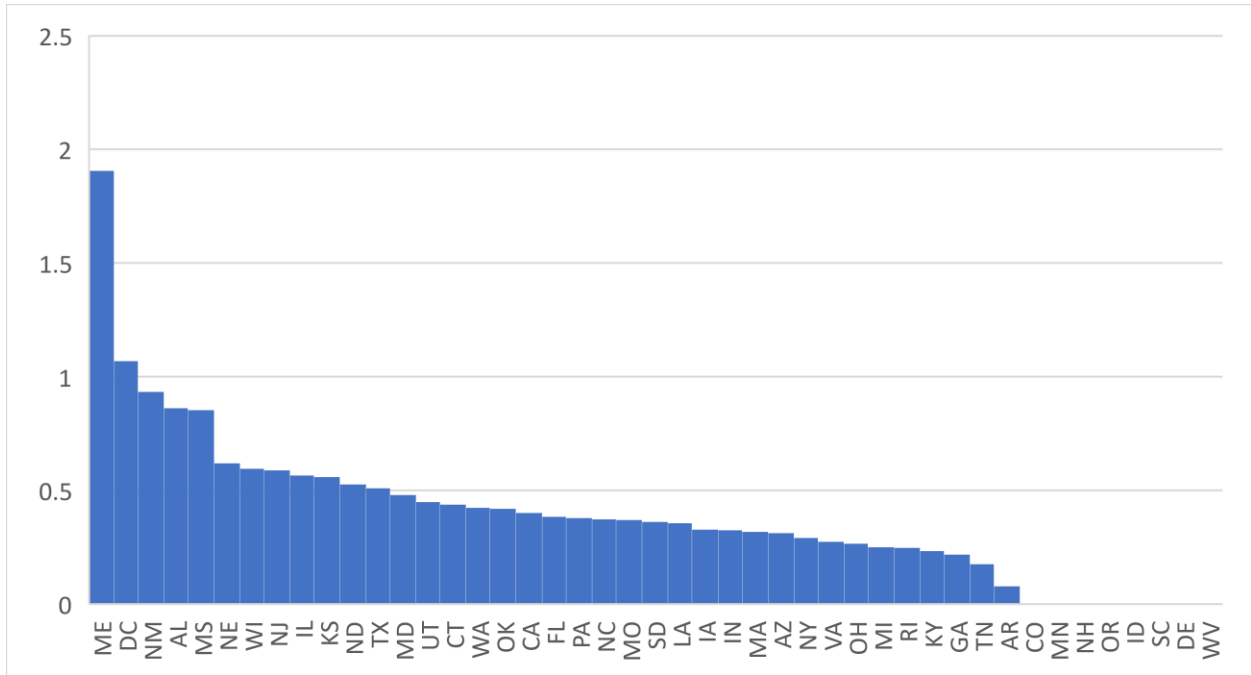
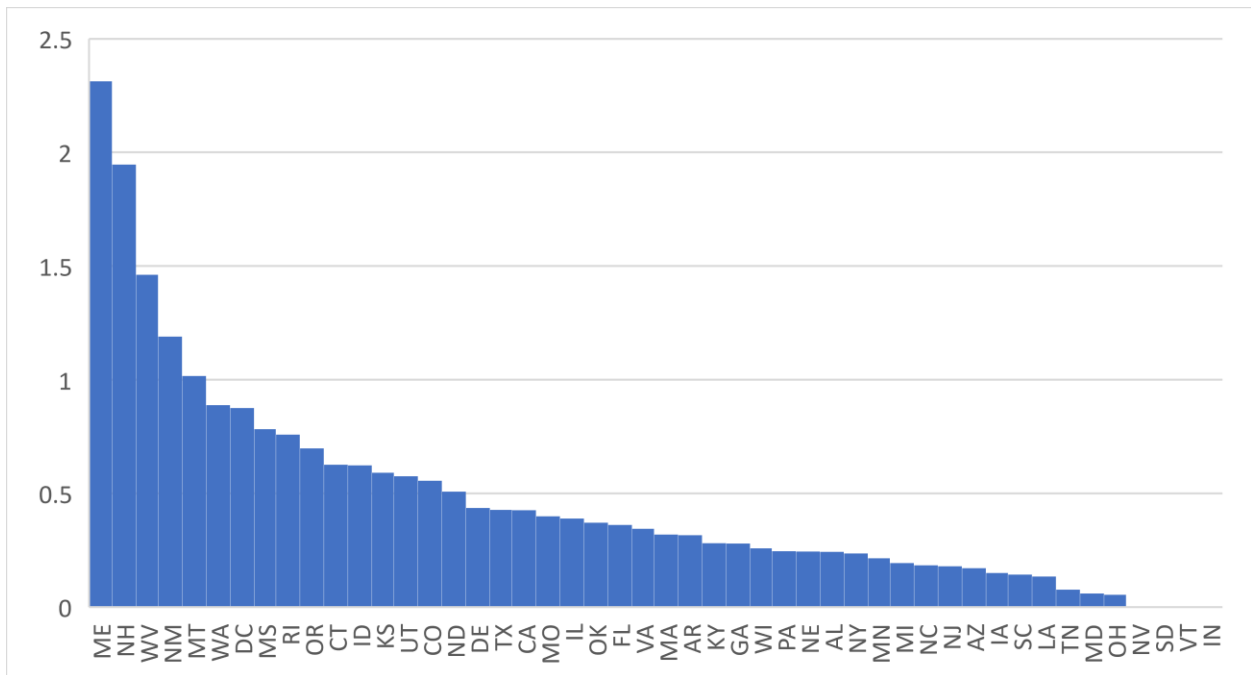


Figure 23. Black/Hispanic Diversity Index of Community College Background Physical Therapy Graduates by State



APPENDIX F. Linear Regression Models: Percentage of Graduates with Community College Background vs. State-Level Community College Availability/Enrollment, Funding & Cost

Table 1. Linear Regression Models: Percent of Dentistry Graduates with CC Background vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	1.00**				0.88*	1.00**
State CC appropriations per FTE (\$1000)		-1.09			-1.30	
State & local CC appropriations per FTE (\$1000)			0.04			-0.49
Average CC tuition & fees (\$1000)				-1.73	-1.83	-1.41
Intercept	11.91	28.70	23.74	32.12	25.51	20.07
R ²	0.21	0.02	0.0001	0.06	0.28	0.26
Observations (states)	34	34	34	34	34	34

*p<0.05, **p<0.01

Table 2. Linear Regression Models: Percent of Dentistry Graduates with CC Background vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	1.62**				1.53**	1.43**
State CC appropriations per FTE (\$1000)		0.45			0.39	
State & local CC appropriations per FTE (\$1000)			1.80*			0.55
Average CC tuition & fees (\$1000)				-2.86*	-1.10	-1.18
Intercept	14.40	34.29	26.40	47.32	18.48	18.63
R ²	0.36	0.003	0.09	0.09	0.38	0.38
Observations (states)	46	46	46	46	36	46

*p<0.05, **p<0.01

Table 3. Linear Regression Models: Percent of Occupational Therapy Graduates with CC Background vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	1.41**				1.27**	1.31**
State CC appropriations per FTE (\$1000)		-1.11			-0.23	
State & local CC appropriations per FTE (\$1000)			0.86			-0.12
Average CC tuition & fees (\$1000)				-2.63	-1.29	-1.23
Intercept	16.08	38.52	30.16	45.34	24.00	23.14
R ²	0.23	0.01	0.01	0.07	0.24	0.24
Observations (states)	44	44	44	44	44	44

*p<0.05, **p<0.01

Table 4. Linear Regression Models: Percent of Physical Therapy Graduates with CC Background vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	1.31**				1.13**	1.16**
State CC appropriations per FTE (\$1000)		-0.70			-0.21	
State & local CC appropriations per FTE (\$1000)			0.53			-0.04
Average CC tuition & fees (\$1000)				-3.04*	-1.75	-1.70
Intercept	11.40	30.64	25.36	40.65	21.69	20.69
R ²	0.26	0.006	0.009	0.11	0.29	0.29
Observations (states)	47	47	47	47	47	47

*p<0.05, **p<0.01

APPENDIX G. Linear Regression Models: Percentage of Black/Hispanic Community College Background Graduates vs. State-Level Community College Availability/Enrollment, Funding & Cost

Table 5. Linear Regression Models: Percent of Black/Hispanic CC Background Dentistry Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	-0.54				-0.19	-0.80
State CC appropriations per FTE (\$1000)		5.53*			6.27*	
State & local CC appropriations per FTE (\$1000)			1.92			2.33
Average CC tuition & fees (\$1000)				0.66	2.47	0.43
Intercept	22.25	-3.87	5.66	12.48	-14.24	12.24
R ²	0.02	0.18	0.05	0.003	0.22	0.09
Observations (states)	34	34	34	34	34	34

*p<0.05, **p<0.01

Table 6. Linear Regression Models: Percent of Black/Hispanic CC Background Pharmacy Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	0.23				0.17	0.22
State CC appropriations per FTE (\$1000)		-0.30			-0.43	
State & local CC appropriations per FTE (\$1000)			0.02			-0.21
Average CC tuition & fees (\$1000)				-0.70	-0.65	-0.53
Intercept	12.76	16.96	15.74	18.62	17.71	16.09
R ²	0.01	0.002	0.000	0.008	0.02	0.02
Observations (states)	46	46	46	46	46	46

*p<0.05, **p<0.01

Table 7. Linear Regression Models: Percent of Black/Hispanic CC Background Occupational Therapy Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	1.20**				1.17**	1.09**
State CC appropriations per FTE (\$1000)		-0.46			0.45	
State & local CC appropriations per FTE (\$1000)			1.12			0.34
Average CC tuition & fees (\$1000)				-1.94	-0.60	-0.69
Intercept	-5.01	12.28	4.86	18.62	-3.84	-2.57
R ²	0.28	0.004	0.04	0.07	0.29	0.29
Observations (states)	44	44	44	44	44	44

*p<0.05, **p<0.01

Table 8. Linear Regression Models: Percent of Black/Hispanic CC Background Physical Therapy Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	0.96*				0.89*	0.76*
State CC appropriations per FTE (\$1000)		0.92			1.26	
State & local CC appropriations per FTE (\$1000)			0.70			0.22
Average CC tuition & fees (\$1000)				-2.86	-1.56	-1.90
Intercept	-1.73	7.23	6.85	22.27	1.09	7.43
R ²	0.18	0.01	0.02	0.14	0.26	0.24
Observations (states)	47	47	47	47	47	47

*p<0.05, **p<0.01

APPENDIX H. Black/Hispanic Diversity Index of Community College Background Graduates vs. State-Level Community College Availability/Enrollment, Funding & Cost

Table 9. Linear Regression Models: Black/Hispanic Diversity Index of CC Background Dentistry Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	-0.05				-0.04	-0.06
State CC appropriations per FTE (\$1000)		0.26			0.26*	
State & local CC appropriations per FTE (\$1000)			0.07			0.10
Average CC tuition & fees (\$1000)				-0.01	0.06	-0.02
Intercept	1.28	-0.29	0.26	0.64	-0.05	1.03
R ²	0.09	0.22	0.04	0.0001	0.29	0.18
Observations (states)	34	34	34	34	34	34

*p<0.05, **p<0.01

Table 10. Linear Regression Models: Black/Hispanic Diversity Index of CC Background Pharmacy Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	-0.05				-0.06	-0.06
State CC appropriations per FTE (\$1000)		0.10			0.08	
State & local CC appropriations per FTE (\$1000)			-0.02			0.02
Average CC tuition & fees (\$1000)				-0.03	-0.06	-0.09
Intercept	1.52	0.43	0.90	0.90	1.53	1.89
R ²	0.05	0.02	0.001	0.001	0.07	0.06
Observations (states)	46	46	46	46	46	46

*p<0.05, **p<0.01

Table 11. Linear Regression Models: Black/Hispanic Diversity Index of CC Background Occupational Therapy Graduates vs. State-Level CC Variables

	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	0.01				0.02	0.01
State CC appropriations per FTE (\$1000)		0.02			0.04	
State & local CC appropriations per FTE (\$1000)			0.04			0.03
Average CC tuition & fees (\$1000)				-0.03	-0.01	-0.02
Intercept	0.20	0.29	0.20	0.51	0.09	0.19
R ²	0.04	0.01	0.04	0.02	0.07	0.07
Observations (states)	44	44	44	44	44	44

*p<0.05, **p<0.01

Table 12. Linear Regression Models: Black/Hispanic Diversity Index of CC Background Physical Therapy Graduates vs. State-Level CC Variables

Physical Therapy CC Background Graduates Diversity Index (Black/Hispanic)	Simple Regression	Simple Regression	Simple Regression	Simple Regression	Multiple Regression #1 (State approps)	Multiple Regression #2 (State & local approps)
CC FTEs per 1000	-0.01				-0.01	-0.01
State CC appropriations per FTE (\$1000)		0.08*			0.08*	
State & local CC appropriations per FTE (\$1000)			0.05			0.05
Average CC tuition & fees (\$1000)				-0.02	-0.01	-0.02
Intercept	0.58	0.16	0.21	0.54	0.28	0.48
R ²	0.01	0.07	0.05	0.003	0.07	0.07
Observations (states)	47	47	47	47	47	47

*p<0.05, **p<0.01