



The AIR Professional File

Spring 2023 Volume

Supporting quality data and
decisions for higher education.



ASSOCIATION
FOR INSTITUTIONAL
RESEARCH

**FEATURING THREE ARTICLES FROM
NCES DATA INSTITUTE TEAMS**

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LETTER FROM AIR'S EXECUTIVE DIRECTOR

I am pleased to introduce three outstanding articles for the Spring 2023 issue of the *AIR Professional File*. Each of these papers explore different facets of the important and complex interdependencies among students, institutions, and disciplines. All three articles use federal datasets and are based on research projects started as part of the National Center for Education Statistics (NCES) Data Institute. The NCES Data Institute (Institute) is a long-standing partnership between NCES and AIR to provide an intensive introduction to federal educational datasets and research methodology. The training is supported by NCES and is developed and operated by AIR.

For over two decades, the Institute has provided opportunities for IR/IE professionals, graduate students, faculty, and other researchers to learn more about the rich array of information within the NCES datasets as well as methodologies and tools to use the datasets effectively. The research that has emerged from this learning and exploration has fueled a multitude of studies that, in turn, have increased our understanding on topics such as student enrollment and graduation patterns; the impact of institutional actions and support; and much, much more. Research partnerships have been forged and lasting connections and friendships have developed among participants.

The Institute has also been the catalyst for journal articles, dissertations, conference presentations, and policy papers that have supported and advanced the career journeys of the participants themselves. The

successful completion of my own dissertation was supported by the knowledge, skills, and connections I gained through participation in one of the early Institutes. Thus, I personally attest to its value and impact.

The three papers in this volume add to the impressive record of Institute participants contributing new and meaningful insights to higher education research through the use of federal datasets.

Andrea Chambers, Hollie Daniels, John Dooris, Arlyn Y. Moreno Luna, and Sean Riordan use the Beginning Postsecondary Students Longitudinal Study (BPS) to explore the question of whether adult students who begin their postsecondary education at a 2-year institution are more or less likely to attain a bachelor's degree as compared to adult students who begin at a 4-year public or 4-year private nonprofit institution. They found no differences in the likelihood of persistence to a bachelor's degree across the various institution types - after controlling for common predictors of persistence such as high school GPA, receipt of Pell Grants, and other demographic data. They also found no differences in persistence for adult students when examining different levels of enrollment intensity (full time and part time).

Sooji Kim, Sarah Parsons, Kimberly Y. Franklin, and Alyse Gray Parker use IPEDS data and a conceptual framework of "servingness" to study the extent to which Hispanic-Serving Institutions (HSIs) serve

LETTER FROM AIR'S EXECUTIVE DIRECTOR

Latinx students as measured by 6-year graduation rates. Their findings suggest that the 6-year graduation rates for Latinx students are lower at HSIs as compared to non-HSIs, even when taking into account the proportion of Latinx students and Latinx faculty. They also found that increased institutional spending on research, academic support, and institutional support are positively associated with graduation rates.

Trang C. Tran, Jon Williams, Kyndra V. Middleton, Angela Clark-Taylor, and Christen Priddie use the High School Longitudinal Study (HLS) to examine the influences that gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion have on Black, Indigenous and People of Color (BIPOC) students' postsecondary major (STEM or non-STEM). The results of their study indicate that gender, science identity, career expectations at age 30, and high school STEM credit completion significantly predict the odds of postsecondary enrollment in a STEM major.

I hope your understanding is expanded and your curiosity sparked by these excellent papers.

Sincerely,
Christine M Keller

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Does the Starting Point Matter? Analyzing Bachelor's Degree Attainment for Adult Students by Institutional Type

Andrea Chambers, Hollie Daniels, John Dooris, Arlyn Y. Moreno Luna, and Sean Riordan

About the Authors

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Abstract

Using the National Center for Education Statistics (NCES) 2012/17 Beginning Postsecondary Students Longitudinal Study (BPS:12/17), this research study explores the persistence to bachelor's degree attainment of adult students. Specifically, this study looks at adult students who expected to earn a bachelor's degree or higher, and analyzes whether those students who begin their postsecondary education at a 2-year public or private nonprofit institution are more or less likely to attain a bachelor's degree compared to adult students who begin at a 4-year public or 4-year private nonprofit institution. Our findings indicate that, after controlling for common predictors of persistence such as high school GPA, receipt of Pell Grants, and other demographic data, adult students who begin at a 2-year public or private nonprofit institution are no less likely to attain a bachelor's degree compared to adult students who start at a 4-year public institution. In addition, full-time enrollment intensity does not increase the odds of persistence compared to mixed enrollment intensity for adult students.

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Keywords: adult students, academic outcomes, community college, persistence, retention

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INTRODUCTION

Adult students age 25 or older are a major component of higher education in the United States, comprising approximately 25% of all undergraduate students in U.S. colleges and universities, with the majority of adult students beginning college at 2-year institutions.¹ In 2019, approximately one in three students at 2-year institutions was age 25 and older, and approximately one in five undergraduate students at 4-year institutions was age 25 and older (National Center for Education Statistics [NCES], 2021). Despite the large population of adult students, there has been a strong focus on traditional-age students in research on student retention and graduation. Degree completion rates for adult students have been increasing in recent years, but those rates are still significantly lower than those of traditional-age students, with 50.5% of adult students graduating within 6 years compared to 64.1% of traditional-age students (Causey et al., 2022). Taniguchi and Kaufman (2005) found that various factors commonly associated with adult students, such as being enrolled only part time and parenting young children, significantly deterred college completion. There is also a pattern of disparities in completion rates by race/ethnicity for adult students, with the rate for Asian adult students completing a degree within 6 years at 66.6%, the rate for White adult students at 43.8%, the rate for Hispanic adult students at 37.7%, and the rate for Black adult students at 37.6% (Causey et al., 2022). While women have outpaced men in college completion rates over the past few decades, completion rates among adult students have been

higher for male students, beginning with the 2011 cohort of first-time students. The most recent 6-year completion rate for adult male students was 50.7%, while the most recent 6-year completion rate for adult female students was 48.2% (Causey et al., 2022).

This study analyzes how beginning postsecondary education at a 2-year institution influences the persistence of adult students compared to beginning at a 4-year institution. More specifically, our research question asks, for adult students who expected to earn a bachelor's degree or higher, how does beginning at a public or private nonprofit 2-year institution influence bachelor's degree attainment compared to beginning at a 4-year public or 4-year private nonprofit institution? In the following sections, we detail influential determinants of adult degree attainment, including institutional starting point; academic advising; institutional context; and environmental factors and academic momentum. We then detail our theoretical framework, and suggest that common academic persistence and degree attainment frameworks fail to consider adult students. We then describe our methodology, present our results, discuss the impact of institutional level and enrollment intensity on adult student degree completion, and, finally, analyze limitations of our research and suggest avenues for future research.

LITERATURE REVIEW

Previous research suggests that adult students and traditional-age students navigate higher education

1. Authors' calculations using NCES PowerStats, BPS:2012/17 data.

differently; these differences can present unique challenges to persistence in students' degree programs.

Institutional Starting Point

Each year, community colleges provide a critical point of entry to higher education for millions of students, particularly for adult students. About one third of undergraduate students in the United States are enrolled in community colleges, and approximately one third of community college students are age 25 and older (NCES, 2021). A major function of U.S. community colleges is their role in providing transfer opportunities to students who may wish to continue their postsecondary education beyond the community college level. Although the vast majority of community college students aspire to earn a bachelor's degree, 6 years after first enrolling fewer than 16% of students who had enrolled in community college expecting to earn a bachelor's degree or higher had done so.² Transfer likelihood differs by socioeconomic status, age, race/ethnicity, educational background, and parental educational attainment; older students, students of color, low-income students, and first-generation students all have lower probabilities of upward transfer than other students (Bailey et al., 2005; Bowen et al., 2009; Dougherty & Kienzl, 2006; Gross & Goldhaber 2009; Wang, 2009; Wood et al., 2011). Other risk factors that have been associated with lower transfer probability include working a full-time job, being a single parent, being enrolled part time, and lacking a high school diploma (Adelman, 2006).

Academic Advising

The field of academic advising emerged in the late 19th century, and has continued to grow throughout the 20th and 21st centuries, particularly as the population of students entering colleges and universities has become more diverse, with varying student needs and degree aspirations (Thelin, 2011). While a large body of research on academic advising focuses on student satisfaction, engagement, and advising's relationship to graduation rates at 4-year institutions (Kuh et al., 2011; Lan & Williams, 2005), a smaller portion of research has evaluated students who begin at a 2-year institution with hopes of transferring to a 4-year institution. In one such study, Bahr (2008) found higher success rates in remedial or developmental coursework, as well as greater odds of transferring to 4-year institutions, for those who received academic advising. Further studies have demonstrated the importance and influence of advisors' relationships with students in successfully transferring to 4-year institutions (Packard & Jeffers, 2013), as well as greater satisfaction with advising among students who successfully transferred (Allen et al., 2014).

Institutional Context

Some of the barriers that adult students face in persisting in their programs and attaining a degree are at the institutional level. Policies, procedures, and attitudes toward adult students create an institutional culture that adult students may see as either welcoming or threatening (Schwehm, 2011).

2. Authors' calculations using NCES PowerStats, BPS:2012/17 data.

Askham (2008) explored these possibilities, identifying both a positive and a negative context within higher education that shaped the adult student's experience. The positive context, or learning community, represented the social support that adult students experienced through assistance from the institution, family, and friends. The negative context, or alien culture, manifested itself as a culture of confusion in higher education, including policies, procedures, and other issues that are intimidating to the adult student. In essence, the community college mirrored the learning community while the university exemplified the alien culture. Adult transfer students, in particular, have to adapt to two separate institutional cultures to be successful. It is the responsibility of the institution to help adult students navigate these differing cultures, minimizing the negative elements of the alien culture while providing an opportunity for the adult student to thrive as part of the learning community.

Using survey data from 32 2-year institutions, Hawley and Harris (2005) found that the characteristics impacting persistence can be classified into three categories: (a) barriers, (b) motivations and aspirations, and (c) expectations. *Barriers* included the amount of developmental coursework a student would have to take, as well as other characteristics such as English proficiency. *Motivations and aspirations* included whether they planned to transfer to a 4-year institution and how focused they were on obtaining their degree. *Expectations* included how long they planned to stay at the institution, as well as other areas such as family and job responsibilities, which could also be seen as barriers. Each of these three categories was found to contain significant predictors of attrition.

External Environmental Factors and Academic Momentum

Other important predictors of persistence among adult students are external environmental factors that could influence enrollment (Bean & Metzner, 1985; Bergman et al., 2014; Braxton et al., 2004; Hagedorn et al., 2008), since many adult students are balancing work, family, and school. Research suggests that family responsibilities can have a direct negative influence on adult student college success (Berkner et al., 2000; Horn & Carroll, 1996; Tinto, 1993). For many adult students who have family obligations, part-time enrollment can provide more-flexible course schedules and lower per semester costs, which might be beneficial to their persistence (Chen, 2007).

In a 2018 article on Complete College America's (CCA) website, Sarah Ancel acknowledged that adult students face unique challenges that traditional-age students are less likely to face, such as the need to work and/or to find child care. In response to these challenges, Ancel promoted compressed course schedules—schedules in which adult students take courses year-round in compressed schedules of one or two courses at a time in 4- to 8-week sessions—as a promising approach to help adult students maintain a 30-credit-hour load per year and so increase graduation rates (Ancel, 2018). While the article cited several case studies with promising results, it nonetheless continued to promote full-time enrollment for greater persistence, even for adult students. The author suggested that adult students who attend less than full time face a lower likelihood of graduating, writing that the traditional academic calendar “leaves these adult students with a difficult tradeoff: make life-altering sacrifices

to attend college full-time or go part-time with significantly greater long term costs and a lower likelihood of reaching graduation” (Ancel, 2018, para. 5).

CCA encourages states and institutions to adopt “15 to Finish” policy initiatives with the belief that academic momentum can help students overcome some of the barriers to completion. These initiatives typically include publicity campaigns encouraging students to enroll in at least 15 credit hours per semester, including an offer of financial aid incentives to do so. More than 25 states and more than 200 institutions are currently engaged in 15 to Finish campaigns (CCA, 2022). CCA cites descriptive statistics from the Beginning Postsecondary Students Longitudinal Study 2004/2009 (BPS:04/09) showing that students, regardless of work schedule, race, gender, or socioeconomic status, were more likely to graduate if they enrolled in more credit hours (CCA, 2013). In critiquing the 15 to Finish campaign, however, Goldrick-Rab (2016) noted, “It may not be that it’s the pace of their momentum that causes improved outcomes—students who move faster vs. slower are often different people who are destined to finish college at different rates independent of their pace” (para. 3).

There are often financial obstacles that prevent students from enrolling in more courses. According to the 2014 National Student Financial Wellness Study, a large-scale survey of student financial wellness, 32% of community college students indicated that the primary reason they were taking extra time to complete a degree was because they had to take fewer classes in order to work more, while just 16% of students at 4-year public institutions responded similarly (National Student

Financial Wellness Study, 2014). Tod Massa, director of policy research and data warehousing for the State Council of Higher Education for Virginia, has noted, “For some students, credit load is a function of overall affordability, particularly of their flexible or indirect costs such as textbooks and commuting costs” (Fain, 2016, para. 31).

While there is some evidence that initially attempting 15 versus 12 credit hours per semester improves degree completion, even after controlling for academic and socioeconomic status variables (Attewell & Monaghan, 2016), the same research noted that undergraduates who work 30 or more hours per week did not benefit from a higher course load. Chan (2020) used a difference-in-differences method to examine the impact of Indiana’s implementation of a 30-credit hour minimum annual completion policy for their promise program, the 21st Century Scholars Program. Chan (2020) found that the requirement of a minimum of 30 credit hours did not have an effect on degree completion at the two institutions under examination: (a) Indiana University–Bloomington and (b) Indiana University–Purdue University Indianapolis.

THEORETICAL FRAMEWORK

Theoretical models surrounding student retention have long been present in higher education literature. For example, Tinto’s (1993) theory of student departure identifies academic difficulties, the inability of individuals to resolve their educational and occupational goals, and individuals’ failure to remain incorporated in the intellectual and social life of an institution as major contributors to

student attrition. Other retention models include Astin's (1977, 1991, 1993) inputs-environment-outputs framework, and Bean and Eaton's (2016) psychological model of student departure. However, these models have often been applied to full-time, traditional-age residential college students and might not have identified the factors that are critical for understanding adult undergraduate student persistence.

Adult student retention models seek to incorporate elements related to adult students' college experiences. The theory of adult learner persistence in degree completion programs model by Bergman et al. (2014) includes (a) student entry characteristics, (b) external environmental characteristics, and (c) internal campus environmental characteristics. Of the three, internal campus characteristics were found to have the greatest effect on persistence. Additionally, their study found that persistence rates were lower among students who believed that their work and their academics conflicted to a great extent. Financial aid and the ability to pay for their degree were also significant factors (Bergman et al., 2014).

Bean and Metzner's (1985) conceptual model of undergraduate nontraditional student attrition found patterns in student departure among adult students that differed from patterns among traditional-age students, specifically that the former students were more affected than the latter by factors that were external to the college environment. Social integration variables existed both internally and externally to the college, but the internal variables had little impact on retention, while the external variables were more predictive. The process of attrition was expected to be similar regardless of the type of institution.

METHODOLOGY

We analyzed data from BPS:12/17, conducted by the NCES at the U.S. Department of Education. The BPS is a large, nationally representative sample survey of first-time beginning undergraduate students in the United States, and collects data on a variety of topics, including persistence, transfer, degree attainment, demographic characteristics, and workforce entry. Data were collected from student surveys and administrative data sources, such as academic transcripts and financial aid records. BPS data include students who are not direct entrants to college from high school, which allows researchers to analyze adult students' degree attainment.

We created a logistic regression model to determine if control and level of institution (2-year public or private nonprofit, 4-year public, 4-year private nonprofit) were associated with bachelor's degree attainment rates for adult students who expected to earn a bachelor's degree or higher. Using the theory of adult learner persistence in degree completion programs (Bergman et al., 2014) and the conceptual model of undergraduate nontraditional student attrition (Bean & Metzner, 1985) as theoretical frameworks, we used a stepwise regression approach, starting with no control variables and adding variables to test model fit. Variables that substantively improved the model fit were included, whereas those that did not were excluded. Our model included the following control variables:

- *High school GPA* included three groups: (a) below 3.0 (reference group), (b) 3.0 or higher, and (c) skipped/not applicable.
- *Gender* included two groups: (a) male (reference group); and (b) female.
- *Race/ethnicity* included two groups:

(a) White or Asian (reference group); and (b) underrepresented minority (URM) or more than one race.

- *First-generation status* indicated whether a parent of the student (a) had completed a bachelor's degree or higher (reference group), or (b) had not completed a bachelor's degree or higher.
- *Enrollment intensity* indicated whether the student's first enrollment spell was (a) full time, (b) part time, or (c) a mix of full time and part time (reference group). Note that the term "enrollment spell" is defined in BPS as a period of enrollment without a break of more than 4 months (NCES, 2022; definition at SENUM6Y). The "enrollment intensity" variable in BPS is derived from student interviews (NCES, 2022; definition at ENINPT3Y). The guideline of 12 semester or quarter hours per term was used regarding full-time status at the undergraduate level (NCES, 2022).
- *Work intensity* was grouped into whether an enrolled student in 2011–2012 had (a) full-time job, (b) part-time job, or (c) no job (reference group).
- *Academic advising* indicated whether a student in 2011–2012 (a) used academic advising services or (b) did not use academic advising services (reference group).
- *Pell recipient* indicated whether a student in 2011–2012 (a) received a Pell Grant, or (b) did not receive a Pell Grant (reference group).
- *Dependents* indicated whether a student in 2011–2012 had (a) a dependent(s), or (b) no dependent(s) (reference group).
- *Academic confidence* denoted the student's answer on a 1 (Strongly Disagree) to 5 (Strongly

Agree) Likert scale to the statement, "After having been at my first institution for a while, I am confident that I have the ability to succeed there as a student." Two groups were created: (a) "Strongly Agree," and (b) all other responses less than "Strongly Agree" (reference group).

In addition to these control variables, we included the control and level of the first institution as our primary independent variable of interest. The three groups of institutions are (a) 2-year public or private nonprofit (reference group), (b) 4-year public, (c) 4-year private nonprofit. The dependent variable was a dichotomous variable indicating whether the student had attained a bachelor's degree.

While the details of BPS survey weighting are outside the scope of this paper, it is important to note that the BPS:12/17 sample is a subset of the 2011–2012 National Postsecondary Student Aid Study (NPSAS:12), which is itself a sample survey of undergraduate and graduate students. Because we did not obtain a restricted-use data license for BPS:12/17, we conducted our analysis through the NCES online application PowerStats, in which appropriate survey weightings are applied to the underlying BPS sample data to compute population estimates and standard errors. For this study in PowerStats, the final cross-sectional student weight (WTA000) was used for both the logistic regression and all descriptive statistics. Details of weighting and variance estimation can be found in the BPS:12/17 data file documentation (Bryan et al., 2019). There were more than 22,000 respondents in BPS:12/17, but because we limited our analysis to adult students who reported an expectation to earn a bachelor's degree or higher, our sample size was approximately 700 students.³

3. Note that, per NCES standards, exact sample sizes are modified in PowerStats to minimize disclosure risks of individual responses.

RESULTS

Descriptive Statistics

Using the BPS:12/17 data set, descriptive statistics were first calculated to characterize the sample (see Table 1 in the appendix). Overall, the sample population of adult students included a mostly even split between males (50.95%) and females (49.04%), with 4-year institutions having slightly more females (53.86%) than males (46.13%) and 2-year institutions having slightly more males (52.24%) than females (47.75%). There were more White or Asian students (61.92%) than URM students or students of more than one race (38.07%). Also, 20.59% of students reported a high school GPA below 3.0, while 22.30% reported a GPA of 3.0 or higher (an additional 57.10% did not respond). The majority of students were first-generation (84.35%); 2-year institutions had a higher percentage of first-generation students (85.98%) in comparison to 4-year institutions (78.27%). More than half of the sample strongly agreed that they had academic confidence (54.72%), received Pell Grants (66.58%), and had dependents while in school (58.95%). Overall, the most common enrollment intensity was mixed (43.66%), and most students had no job while in school (50.76%). Tables 2 and 3 in the appendix show the bachelor's degree attainment rates among students who began at a 2-year institution (Table 2) compared to students who began at a 4-year institution (Table 3).

Logistic Regression

While odds ratios for the control variables generally aligned with prior theory and empirical studies (e.g., students with higher GPAs in high school were more likely to graduate than students with lower GPAs), the only statistically significant predictor of

bachelor's degree attainment was control and level of first institution (see Table 4 in the appendix).

Part-time enrollment intensity during the first enrollment spell (i.e., the first period of enrollment without a break of more than 4 months), decreased the odds of a student obtaining a bachelor's degree to essentially zero (0.00 odds ratio) in comparison to mixed enrollment intensity (a mix of full-time and part-time enrollment). Given the extremely large standard error and thus confidence interval, and also based on descriptive statistics on degree attainment rates in Tables 2 and 3, it is likely that no or almost no part-time students in the sample graduated within 6 years; thus, part-time enrollment predicted the outcome variable perfectly or almost perfectly, preventing a maximum likelihood estimate for part-time enrollment. This phenomenon is known as complete or quasi-complete separation. This finding is not surprising because it is nearly impossible for a student enrolled entirely part time to graduate with a bachelor's degree in the 6-year time frame used to measure degree attainment in BPS. However, full-time enrollment intensity did not lead to a statistically significant difference in the odds of a student obtaining a bachelor's degree compared to mixed enrollment intensity.

The odds of obtaining a bachelor's degree were 4.63 times greater for students whose first institution was a 4-year private nonprofit institution compared to students whose first institution was a 2-year public or private nonprofit institution. However, there was no statistically significant difference in the odds of a student whose first institution was a 4-year public institution obtaining a bachelor's degree compared to a student whose first institution was a 2-year institution. While previous research has indicated that bachelor's degree completion rates for students who start at 2-year institutions

are much lower than those rates at 4-year public institutions, once we controlled for demographic, socioeconomic, and academic characteristics, we found that adult students were just as likely to attain their goal of earning a bachelor's degree when they started at 2-year institutions as when they started at 4-year public institutions. This finding is important because most adult students hoping to earn a bachelor's degree start at 2-year institutions, which are often the most accessible and affordable option in higher education; approximately 76.6% of adult students start at a 2-year institution, 15.9% start at a 4-year public institution, and 7.6% start at a 4-year private nonprofit institution.⁴ The 2-year institutions provided adult students with a steppingstone to 4-year institutions without compromising their bachelor's degree attainment rate.

DISCUSSION

Two-year institutions play an important role in making higher education accessible for students, particularly adult students (Kolbe & Baker, 2019). In the 2020–2021 academic year, more than 7 million undergraduates attended 2-year public institutions (Community College Research Center, n.d.), and most adult students begin their higher education pathway at 2-year institutions.⁵ Although there is a growing body of literature on transfer students, our study contributes to the literature by focusing on adult student degree attainment by institutional type and by enrollment intensity.

Building from previous research in this area, this study presents two major findings. First, our study indicates that beginning at a 2-year public

or private nonprofit institution does not have a negative influence on bachelor's degree attainment compared to starting at a 4-year public institution for adult students whose goal is to earn a bachelor's degree. This is an important finding and contribution to the literature since previous research, often not controlling for students' degree attainment goals, demographic, socioeconomic, and academic characteristics, has shown that degree attainment is lower for students who begin at 2-year institutions in comparison to those who begin at 4-year institutions (Dowd et al., 2020). This is good news since most adult students begin their higher education path at 2-year institutions where admissions are typically open to all students; in addition, 2-year institutions are typically more economical and more geographically accessible to students (Grubb, 2009).

Finally, when examining enrollment intensity, full-time enrollment intensity does not increase the odds of persistence compared to mixed enrollment (full time and part time) intensity for adult students. This finding is important because it suggests that the message of college completion advocacy groups, such as CCA and its 15 to Finish campaign (CCA, 2022), might not be appropriate for adult students.

LIMITATIONS AND FUTURE RESEARCH

A limitation of this study was the small sample size. After filtering the BPS data set to address our research question, the sample was approximately 700 students. This small sample size presented some analysis problems in PowerStats. We had to combine certain categorical variables, such as

4. Authors' calculations using NCES PowerStats, BPS:2012/17 data.

5. Authors' calculations using NCES PowerStats, BPS:2012/17 data.

URMs, instead of modeling outcomes for individual minority categories, when PowerStats returned error messages regarding an insufficient number of observations in a predictor variable. Given the small sample size, this analysis is likely underpowered—meaning there could be differences in attainment that we could not detect—for example, by Pell Grant status or GPA. We also might see differences in attainment by public 4-year and 2-year institutions if we had a larger sample. The underpower issue is also causing large variance of estimates. Even though we detected a significant effect for 4-year private nonprofit institutions, the 95% confidence interval for the odds ratio ranged from 1.2 to 17.7. This range is likely too large to inform public policy decisions.

Another limitation was the 6-year time frame of the BPS study. A longer time frame would be better to understand attainment rates for part-time students. This restriction-of-range problem might also be affecting the odds ratios for mixed enrollment intensity. Similar to part-time students, some mixed enrollment intensity students likely take longer than 6 years to earn a bachelor's degree. If the BPS time frame were extended, we might detect a higher level of bachelor's degree attainment for both part-time and mixed enrollment intensity students.

Finally, the finding that full-time enrollment intensity did not lead to a statistically significant difference in the odds of a student obtaining a bachelor's degree compared to mixed enrollment intensity should be considered with caution. The probability of a student enrolling with mixed intensity (full time and part time) likely increases as the number of terms a student is enrolled increases (e.g., a student enrolled full time for one term and part time the next term). In other words, the number of terms enrolled may be positively related to mixed enrollment intensity,

and the number of terms enrolled is certainly positively related to graduation (e.g., a first-time undergraduate student enrolled for only one or two terms will not graduate, while a student enrolled for eight terms has potentially earned enough credit hours to graduate). Future studies may want to explore controlling for months of enrollment.

Future research would also benefit from conducting a deeper analysis that incorporates additional explanatory variables, such as institutional selectivity and interaction terms. We conducted our analysis through the NCES online application PowerStats due to COVID-19 social distancing restrictions that prevented us from applying for a restricted-use data license. Such restricted-use data would be necessary to model interaction terms. We suspect that there are potential interaction effects, such as enrollment intensity and level of institution, as well as enrollment intensity and work intensity. For example, descriptive statistics revealed that students at 2-year institutions were more likely to graduate when they enrolled with mixed intensity than when they enrolled with full-time intensity, but that students at 4-year institutions were less likely to graduate when they enrolled with mixed intensity than with full-time intensity. We also hypothesize that work intensity could moderate the effect of enrollment intensity on bachelor's degree attainment.

We suggest that researchers continue to explore the realities of higher education for adult students and that future data collection and research consider more nuanced predictors of degree attainment beyond those typical for traditional-age students. This large and growing population of students warrants greater attention if we truly seek to accept educational responsibility for all students.

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APPENDIX

Table 1. Descriptive Frequencies: Demographic Characteristics, Socioeconomic Indicators, and Academic Markers

Variable	Percent	Percent	Percent
GPA in High School	Less than 3.0	3.0 or Higher	Skipped
2-Year Public or Private Nonprofit	23.47%	19.70%	56.82%
4-Year Public, and 4-Year Private Nonprofit	9.86%	31.99%	58.13%
Total	20.59%	22.30%	57.10%
Gender	Male	Female	Total
2-Year Public or Private Nonprofit	52.24%	47.75%	100%
4-Year Public, and 4-Year Private Nonprofit	46.13%	53.86%	100%
Total	50.95%	49.04%	100%
Race/Ethnicity	White or Asian	URM or More Than One Race	Total
2-Year Public or Private Nonprofit	61.34%	38.65%	100%
4-Year Public, and 4-Year Private Nonprofit	64.06%	35.93%	100%
Total	61.92%	38.07%	100%
First-Generation Student	Yes	No	Total
2-Year Public or Private Nonprofit	85.98%	14.01%	100%
4-Year Public, and 4-Year Private Nonprofit	78.27%	21.72%	100%
Total	84.35%	15.64%	100%
Academic Confidence in 2011–2012	Strongly Agree	Do Not Agree	Total
2-Year Public or Private Nonprofit	56.30%	43.69%	100%
4-Year Public, and 4-Year Private Nonprofit	48.82%	51.17%	100%
Total	54.72%	45.27%	100%
Pell Grant in 2011–2012	No Pell	Pell	Total
2-Year Public or Private Nonprofit	34.88%	65.12%	100%
4-Year Public, and 4-Year Private Nonprofit	27.96%	72.03%	100%
Total	33.42%	66.58%	100%
Dependents in 2011–2012	No Dependents	Yes Dependents	Total
2-Year Public or Private Nonprofit	40.88%	59.11%	100%
4-Year Public, and 4-Year Private Nonprofit	41.65%	58.35%	100%
Total	41.04%	58.95%	100%
Enrollment Spell (First): Intensity through June 2017	Full Time	Part Time	Mixed
2-Year Public or Private Nonprofit	20.64%	36.40%	42.95%
4-Year Public, and 4-Year Private Nonprofit	38.63%	15.07% !	46.29%
Total	24.45%	31.89%	43.66%

Work Intensity While Enrolled in 2011–2012	No Job	Part Time	Full Time
2-Year Public or Private Nonprofit	51.26%	12.79%	35.94%
4-Year Public, and 4-Year Private Nonprofit	48.95%	23.57%	27.47%
Total	50.76%	15.15%	34.09%

Academic Advising Used in 2011–2012	No	Yes	Total
2-Year Public or Private Nonprofit	40.72%	59.28%	100%
4-Year Public, and 4-Year Private Nonprofit	48.74%	51.26%	100%
Total	46.99%	53%	100%

Table 2. Bachelor's Degree Attainment Rates for Students that Began at 2-Year Public or Private Nonprofit Institutions

Variable	Attained Bachelor's Degree	Did Not Attain Bachelor's Degree
GPA in High School		
Less than 3.0	2.93% !!	97.07%
3.0 or Higher	11.82% !	88.18%
Skipped	9.27%	90.73%
Gender		
Male	9.34%	90.66%
Female	7.12% !	92.88%
Race/Ethnicity		
White or Asian	10.13%	89.87%
URM or More Than One Race	5.35%	94.65%
First-Generation Status		
First-Generation Student	8.04%	91.96%
Not First-Generation Student	‡	90.26%
Academic Confidence in 2011-2012		
Strongly Agree	11.89%	88.10%
Do Not Strongly Agree	3.62% !	96.37%
Pell Grant in 2011-2012		
Pell Recipient	6.50% !	93.50%
No Pell Recipient	11.60% !	88.39%
Dependents in 2011-2012		
Dependents	8.21%	91.62%
No Dependents	8.28%	91.62%
Enrollment Spell (First): Intensity Through June 2017		
Full Time	4.13% !	95.87%
Part Time	‡	100%
Mixed	17.29%	82.70%
Work Intensity While Enrolled in 2011-2012		
No Job	7.64% !	92.35%
Part Time	14.06% !	85.93%
Full Time	8.89% !	91.11%
Academic Advising Used in 2011-2012		
Yes	5.36% !	94.64%
No	12.29%	87.70%
Total	8.28%	91.72%

Note:

! Interpret data with caution. Estimate is unstable because the standard error represents more than 30% of the estimate.

!! Interpret data with caution. Estimate is unstable because the standard error represents more than 50% of the estimate.

‡ Reporting standards are not met.

Table 3. Bachelor's Degree Attainment Rates for Students That Began at 4-Year Public or Private Nonprofit Institutions

Variable	Attained Bachelor's Degree	Did Not Attain Bachelor's Degree
GPA in High School		
Less than 3.0	‡	‡
3.0 or Higher	10.51% !!	89.49
Skipped	18.56% !	81.44
Gender		
Male	9.96% !!	90.03%
Female	19% !	80.99%
Race/Ethnicity		
White or Asian	16.42%	83.58%
URM or More Than One Race	11.99%	88%
First-Generation Status		
First-Generation Student	14.24%	85.76%
Not First-Generation Student	16.95%	85.05%
Academic Confidence in 2011–2012		
Strongly Agree	11.89%	88.10%
Do Not Strongly Agree	3.62% !	96.37%
Pell Grant in 2011–2012		
Pell Recipient	17.92%	82.08%
No Pell Recipient	6.88% !!	93.11%
Dependents in 2011–2012		
Dependents	12.29% !!	87.70%
No Dependents	18.38% !	81.62%
Enrollment Spell (First): Intensity Through June 2017		
Full Time	18.09% !!	81.90%
Part Time	‡	99.91%
Mixed	16.90%	83.09%
Work Intensity While Enrolled in 2011–2012		
No Job	12.82% !	87.18%
Part Time	‡	‡
Full Time	5.22% !!	94.78%
Academic Advising Used in 2011–2012		
Yes	21.68% !	78.32%
No	11.67% !!	88.33%
Total	14.83% !	85.17%

Note:

! Interpret data with caution. Estimate is unstable because the standard error represents more than 30% of the estimate.

!! Interpret data with caution. Estimate is unstable because the standard error represents more than 50% of the estimate.

‡ Reporting standards not met.

Table 4. Logistic Regression Analysis Predicting Adult Student Attainment of a Bachelor's Degree

Predictor	β	e ^{β} (odds ratio)	p-value	Odds Ratio 95% Confidence Interval	
				Lower	Upper
Intercept	-2.63	0.07	0.41	0	38.94
GPA in High School (Reference Group ≤ 2.9)					
≥ 3.0	1.03	2.81	0.61	0.05	145.13
Skipped	1.12	3.06	0.56	0.07	127.51
Female (reference group: male)	-0.27	0.77	0.68	0.21	2.75
URM or More Than One Race (reference group: White or Asian)	-0.99	0.37	0.2	0.08	1.66
First-Generation Status (reference group: not first-generation)	-0.22	0.8	0.92	0.01	48.52
Academic Confidence in 2011–2012: strongly agree (reference group: responses less than “strongly agree”)	0.67	1.95	0.36	0.47	8.05
Pell Grant in 2011–2012 (reference group: no Pell Grant)	-0.78	0.46	0.25	0.12	1.72
Dependents in 2011–2012 (reference group: no dependents)	-0.03	0.96	0.95	0.31	2.98
Enrollment Spell (First): Intensity through June 2017 (reference group: mixed enrollment)					
Full time	-0.62	0.54	0.31	0.16	1.78
Part time	-7.77	0	0.54	0	22.5 million
Work Intensity While Enrolled in 2011–2012 (reference group: no job)					
Part time	1.28	3.6	0.1	0.78	16.68
Full time	0.36	1.43	0.63	0.34	6.05
Used Academic Advising in 2011–2012 (reference group: did not use)	0.59	1.8	0.44	0.41	7.84
Control and Level of First Institution (reference group: 2-Year Public or Private Nonprofit Institution)					
4-Year Public	-0.29	0.75	0.91	0	117.51
4-Year Private Nonprofit	1.53*	4.63*	0.03	1.21	17.68

* $p < 0.05$

How Do Hispanic-Serving Institutions Serve Latinx Students? A Panel Analysis of Institutional Characteristics and 6-Year Graduation Rates

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Abstract

This study builds on the body of research on Hispanic-Serving Institutions (HSIs) and Latinx student outcomes, and uses Garcia et al.'s (2019) conceptual framework of *servingsness*. Using multiple years of data from the Integrated Postsecondary Education Data System (IPEDS), we examined the extent to which HSIs serve Latinx students in terms of 6-year graduation rates at not-for-profit 4-year institutions. Key findings suggest that the average 6-year graduation rates for Latinx students are lower at HSIs than at non-HSIs.

HSIs and non-HSIs have vastly different institutional characteristics, such as the organizational environment experienced by students and the structural capacity of institutions to respond to students' needs. Moreover, we find that, at HSIs, neither the share of Latinx students nor the share of Latinx instructional staff promote Latinx students' 6-year graduation rates. The graduation rates, however, are positively associated with increased institutional spending on research, academic support, and institutional support, which are organizational structures that can respond to students' needs for academic success, as well as with higher institutional selectivity approximated by an offering of no remedial courses.

Keywords: Hispanic-Serving Institutions; minority-serving institutions; Latinx students; college outcomes; college success

INTRODUCTION

Hispanic-Serving Institutions (HSIs) are among the fastest-growing types of higher education institutions in the United States. HSIs are not-for-profit degree-granting institutions with “an enrollment of undergraduate full-time equivalent students that is at least 25 percent [Latinx] students” (U.S. Department of Education, n.d.-a) and are eligible for federal designation and grant programs such as the Title V program (Garcia, 2017).¹

According to the Hispanic Association of Colleges and Universities (HACU, 2022), there were 559 institutions with HSI designation in 2020, enrolling about two thirds of all Latinx undergraduate students, which is an increase of 248 institutions since 2010. Geographically, HSIs are mostly located in the western and southwestern United States, yet 80% of them are located in California, Florida, Illinois, New Mexico, New York, Texas, and Puerto Rico (HACU, 2022; Hurtado & Ruiz Alvarado, 2015). HSIs have a growing importance in advancing college access and success for Latinx students since the Latinx college-going population is rapidly increasing; that increase, in turn, has contributed to the growth of eligible HSIs (Garcia, 2017; Laden, 2004).² Many scholars have documented the historical origin of HSIs, which dates back at least 30 years (e.g., Garcia, 2020; Gasman et al., 2015; Laden, 2004; Núñez et al., 2015; Santiago, 2006; Vargas & Villa-Palomino, 2019). A large majority of HSIs were initially predominantly White institutions that became Latinx-serving as a result of significant increases in Latinx students’ college enrollment commensurate with demographic changes. Yet, unlike other minority-serving institutions such as Historically Black Colleges and Universities or

Tribal Colleges and Universities, both of which were founded as a result of de jure segregation and with an explicit mission to serve their respective student populations, HSIs were not founded with a specific mission of serving Latinx students (Contreras et al., 2008; Hurtado & Ruiz Alvarado, 2015; Núñez et al., 2015). Rather, HSI designation has been largely defined by an enrollment threshold.

After an intensive period of advocacy and activism that began in the early 1980s from stakeholders concerned with Latinx students’ access to higher education and their upward mobility, HSIs received federal designation with the reauthorization of the Higher Education Act of 1992. This designation enabled HSIs to apply for official recognition and to compete for various federal grants such as the Title III program for science, technology, engineering, and mathematics (STEM) education at HSIs or to apply for the Title V program “to assist with strengthening institutional programs, facilities, and services to expand the educational opportunities for [Latinx] Americans and other underrepresented populations” (U.S. Department of Education, n.d.-b). As Dayton et al. (2004) noted, HSIs indeed have become institutions for “[encountering] opportunities for unique learning environments, access to special funding, and the potential to be instrumental in [Latinx students’] educational attainment” (p. 29). Despite federal recognition, support for HSIs, and an accumulation of research on HSIs, scholars have indicated that what it means to serve Latinx students remains an open question and an opaque concept that lacks specific federal guidelines for promoting strategies to serve Latinx students (Garcia et al., 2019; Santiago, 2006).

1. Federal grant program eligibility such as for Title V requires HSIs “to ensure that at least 50 percent of their [Latinx] students are low-income individuals” (Dayton et al., 2004, p. 29). In this paper we refer to Hispanic/Latino as Latinx, and to Native Hawaiian/Other Pacific Islander as Indigenous.

2. HACU (2022) estimates that Latinx student enrollment in higher education will be more than 4.1 million by 2026.

In this study, we used Garcia et al.'s (2019) framework of servingness to investigate the extent to which HSIs serve Latinx students; in doing so, we focused on Latinx students' 6-year graduation rates. Specifically, we longitudinally examined an overall trend in Latinx students' 6-year graduation rates at not-for-profit degree-granting institutions by control and HSI designation status. We further investigated how various institutional characteristics (e.g., organizational environment and structure) vary between HSIs and non-HSIs, and how these characteristics facilitate or hinder institutions' servingness—that is, the 6-year graduation rates of the Latinx student population. To answer our questions, we conducted a panel analysis of multiple years of Integrated Postsecondary Education Data System (IPEDS) data from 1,266 institutions.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Research on HSIs has increased since their formal recognition in 1992 as a distinctive type of institution. Research has focused on the origins and evolution of HSIs, on Latinx and other minoritized groups of students' access to higher education, and on HSI students' experiences and outcomes (Garcia et al., 2019; Núñez et al., 2015). While some studies solely examined HSIs, other studies comparatively studied HSIs with non-HSIs or emerging HSIs that were approaching the 25% enrollment threshold (Cuellar, 2015; Garcia, 2013; Rodriguez & Calderón Galdeano, 2015). To date, existing studies have documented successes and transformative changes, opportunities for improvement, and capacity building about HSIs (e.g., Contreras & Contreras, 2015; Contreras et al., 2008; Cuellar, 2015; Garcia,

2013; Garcia et al., 2019; Garcia & Guzman-Alvarez, 2021; Rodriguez & Calderón Galdeano, 2015). The findings of the literature, however, appear inconsistent given the differences in how analytic samples of HSIs were constructed, variables examined, or conceptual frameworks and theories used (Núñez et al., 2015). Meanwhile, scholars have consistently stressed that HSIs have contributed to improving Latinx students' access to higher education and degree attainment for those who might not otherwise have had an opportunity to enroll in college (Gasman et al., 2015; Núñez et al., 2015).

The ability to articulate what it means for an institution to be or to become Latinx serving or minority serving in the absence of a clear mandate or mission remains a perennial challenge for higher education research, policy, and practice (Contreras et al., 2008; Garcia, 2019; Marin, 2019; Vargas & Villa-Palomino, 2019). As Garcia et al. (2019) wrote, "There continues to be a debate about what it means to serve students" (p. 745). To examine this issue, they conducted a systematic literature review to clarify the concept of servingness with respect to HSIs and Latinx students in diverse institutional contexts (e.g., 4-year, 2-year, public, private), and suggested a comprehensive, multidimensional conceptual framework of servingness. In this study, we adopted Garcia et al.'s conceptual framework to guide our research questions and estimation model.

Garcia et al.'s (2019) multidimensional conceptual framework of servingness describes indicators of servingness as measurable constructs that represent either the impact of attending or the quality of HSIs. Indicators of servingness are inclusive of both academic (e.g., GPA, 6-year graduation rates) and nonacademic (e.g., academic self-efficacy, racial

identity) outcomes of attending an HSI. In Garcia et al.'s framework, "both types of outcomes happen as a result of time spent within the structures of HSIs, and are affected by experiences, structural elements, and external forces" (p. 772). In this study, we explored the 6-year graduation rates of Latinx students at 4-year institutions as a key indicator of servingness of institutions.

For HSIs "to become truly transformative spaces of serving" (p. 772), Garcia et al. (2019) emphasized, it is important to consider the experiences of students—that is, to consider how students encounter the organizational environment of higher education institutions. To elaborate, institutional constituents such as faculty or staff can impact student experiences, including their experiences at HSIs. Garcia et al. summarized these experiences into two types: (a) validating experiences (positive) and (b) racialized experiences (negative), based on the idea of validation introduced by Rendon (1994). Validating experiences comprise, for example, "interactions with same-race/same-ethnicity peers, faculty, and staff, cultural validation, the ability to speak Spanish on campus, and mentoring, and support [that gives students] academic or social recognition or affirmation of the backgrounds of diverse students and personnel" (Garcia et al., 2019, p. 772). On the other hand, racialized experiences, such as racism, discrimination, or microaggressions, connote negative experiences within the organization. We incorporated the concepts of validating and racialized experiences in this study by accounting for the compositional diversity of students (e.g., percentages of Latinx, White, or Asian students) as well as of instructional staff, and examined how these types of student experiences are associated with Latinx students' 6-year graduation rates.

According to Garcia et al. (2019), the organizational structures of HSIs not only influence student experiences, but also "shape HSIs' capacity to address the needs of Latinx students" (p. 772). In their framework, structures for serving are, for instance, development of an institutional mission that highlights serving, adoption of diversity plans, or applying for grants to serve Latinx students. Not all structural constructs are measurable according to Garcia et al., but they can be observed and studied through case studies or documentation (e.g., through strategic plans). Given the significance of structural characteristics with respect to serving the needs of Latinx students, we investigated various types of organizational structures, including the types of student services offered (e.g., remedial education, employment services), financial aid offers at the institutional level (e.g., the average amount of grant aid per full-time equivalent [FTE] undergraduate student), and institutional expenses (e.g., instruction, research) that could play significant roles in serving Latinx students and that could impact their 6-year graduation rates.

Garcia et al. (2019), moreover, highlighted that there are external influences on the servingness of HSIs, including various historical, political, or social influences. For instance, these influences might be federal, state, or local legislation or political advocacy for the Latinx community or institutional governing boards or alumni at HSIs. In a much broader sense, Garcia et al. emphasized that there is a systemic influence of White supremacy on HSIs. We discuss how we attempt to account for these external influences in the methods section.

Most importantly, by adopting Garcia et al.'s (2019) multidimensional framework for servingness, we

move away from a tendency in prior studies to frame HSIs in binary terms as either serving or non-serving. We instead seek to illuminate the complexity of HSI identity and the diverse institutional characteristics that can contribute to their performance (Garcia et al., 2019). As Marin (2019) noted, “instead of asking whether an institution is [Latinx]-serving, it may be more appropriate to ask about the extent to which an institution is [Latinx]-serving, recognizing the ongoing identity development that may be required and the many ways [Latinx]-serving can be conveyed” (p. 178). In this regard, we investigated to what extent organizational and structural traits of higher education institutions serve Latinx students’ success.

RESEARCH QUESTIONS

In this study, we aim to identify the types of institutional characteristics related to Latinx students’ 6-year graduation rates with a particular interest in HSIs. We address the following three questions:

- 1| How have Latinx students’ 6-year graduation trends changed at HSIs over recent years? Do these trends differ by institutional control and HSI designation status?
- 2| What are the institutional characteristics of HSIs and to what extent are they different from those characteristics at non-HSIs? What kinds of institutional differences are retained over time?
- 3| What are the institutional features of HSIs and non-HSIs that are significantly related to Latinx students’ 6-year graduation rates?

METHODS

Data and Sample

We used multiple IPEDS survey components (e.g., enrollment, admissions, finance, graduation rates, institutional characteristics) to create a panel data set for this study. IPEDS data are aggregated institution-level data collected by the U.S. Department of Education’s National Center for Education Statistics (NCES) from institutions that participate in the federal student financial aid programs (i.e., Title IV programs). We also used the *Digest of Education Statistics* information to gather data about the HSI status of an institution (NCES, 2019). In particular, we used data from Table 312.40, which provided a list of HSIs, their enrollment, and their awarded degree data. Since data on HSI status were not available for years prior to 2015, we focused our analysis on the years 2015–2018. The final sample for this study was limited to 4-year not-for-profit institutions that were Title IV eligible. We restricted our analysis to doctoral (research) universities, master’s colleges and universities, and baccalaureate colleges; we excluded associate’s colleges and special focus institutions (e.g., theological seminaries, health profession schools) as defined by the Carnegie Classification of Institutions of Higher Education (n.d.). Our aim was to keep the sample of institutions comparable in terms of the student population they serve. The final analytic sample included a total of 1,266 institutions.

Measures

All measures included in this study were aggregated at the institutional level and come from multiple

survey components of IPEDS: 12-month enrollment, admissions, finance, graduation rates, human resources, institutional characteristics, and student financial aid.³ The outcome variable we examine is the 150% graduation rates for Latinx students who enrolled at the institution as full-time, first-time degree- or certificate-seeking students. IPEDS defines 150% graduation rate as a student's completion of their program within one and a half times (150%) the normal period of time (NCES, n.d.). In our study, the outcome represented 6-year graduation rates since we focused on 4-year institutions; that outcome served as an indicator measuring the impact or quality of attending an HSI.

The key covariate of our interest was an indicator for HSI status of an institution since our analysis included both HSIs and non-HSIs. An institution was defined as an HSI by having "an enrollment of undergraduate full-time-equivalent students that is at least 25 percent [Latinx]" (NCES, 2019, Table note) who are U.S. citizens or permanent residents. Since HSI status is subject to adjustment due to yearly changes in Latinx student enrollment, an institution's HSI designation is considered as a time-varying feature, which also varies across institutions.

Furthermore, our analysis included various other institution-level measures to account for the Latinx student experience of an organizational environment as well as for the organizational structures for serving Latinx students. First, to reflect how Latinx students may experience the organizational environment, we included measures of racial and ethnic composition of the student body and the instructional staff. Due to the small number of observations, we collectively referred

to American Indian natives and Pacific Islanders as Indigenous. We also controlled for six dichotomous measures of student services/support (i.e., remedial education, academic/career counseling, employment counseling, placement, on-campus day care, physical library), financial aid offers, and six measures of institutional expenses (instruction, research, public service, academic support, student services, institutional support) to address the structures that impact institutions' organizational capacity to serve student needs; an example would be the percent spent on instruction out of the total institutional expense.⁴ For financial aid, we accounted for the average grant aid (i.e., federal, state, local, institutional, all other grant aid) per FTE undergraduate student, and we accounted for the average loan amounts per FTE undergraduate student. These characteristics are considered time-variant characteristics, meaning not only that they are different at each institution, but also that they vary across time (i.e., each year).

Finally, although they were not explicitly discussed within Garcia et al.'s (2019) framework, we descriptively examined institutional characteristics that might be associated with student outcomes such as the total cost of attendance, institutional control, institutional selectivity measured by the percentage of admitted students, and Carnegie classification of the institution. Except for selectivity, all of these characteristics were time-invariant covariates.

3. More information about survey components can be found at IPEDS (n.d.-a).

4. Descriptions of student services can be found at IPEDS (n.d.-b).

Empirical Strategy

We first conducted descriptive analyses to examine the trends in Latinx students' 6-year graduation rates by institutional control and HSI status, as well as to examine the similarities and differences in institutional characteristics between HSIs and non-HSIs. T-tests (for continuous variables) and chi-squared tests (for categorical variables) were also performed to confirm if the differences across institutions were statistically meaningful by their HSI status.

To answer our primary research question about the types of institutional characteristics related to Latinx students' 6-year graduation rates, we conducted a panel analysis of IPEDS data from 2015 to 2018. We considered each of the participating Title IV institutions as the unit of analysis (Jaquette & Parra, 2014) measured at different points in time (e.g., 2015, 2016), and we identified the panel structure of the data accordingly. We estimated a fixed effects model given the result of a Hausman test, which indicated that it was the preferred model rather than a random effects model ($p < 0.05$). In our analysis, we used the `xtreg` command in *Stata* that demeans the variables, and we estimated the standard errors, correctly accounting for the fact that the cases are not independent of each other. Given the continuous outcome variable, our linear regression panel model with fixed effects can be written as

$$y_{it} = \beta_0 + \beta_1 X_{it} + \alpha_i + \lambda_t + \varepsilon_{it}$$

y_{it} is the outcome, a continuous measure of Latinx students' 6-year graduation rate for each institution (i) at time point ($t = 2015, 2016, 2017, 2018$). β_0 is an intercept term that can vary at different time periods. X_{it} is a set of time-varying covariates such as the proportion of Latinx students, faculty-student

ratio, institutional selectivity, financial aid offers, or institutional expenses. α_i is an institution fixed effect (i.e., institution dummy variables) that controls for all time-invariant unobserved institution-specific characteristics that might affect the outcome, such as institutional climate. This means that α_i absorbs the impacts of all time-constant institutional characteristics that have not been included in our model. λ_t is a time-fixed effect (i.e., year) that controls for unobservable covariates that vary over time but are fixed across institutions. Finally, ε_{it} is an error term that is different for each institution at each time period (e.g., 2015, 2016), and represents the effects of all time-variant variables that have not been included in our model.

Limitations

There were some aspects of Garcia et al.'s (2019) framework that were not observable through our data. Mainly, we were not able to account for some of the structural factors that, "unlike other outcomes and experiences, [are not] necessarily measurable in traditional ways" (Garcia et al., 2019, p. 773), such as mission and value statements or diversity plans. We attempted to mitigate this limitation by accounting for institutional characteristics such as control or institution type, since these characteristics reflect institutions' orientation (e.g., teaching vs. research) or diversity goals, to some extent; those characteristics do not vary over time in most cases. We also could not account for any external influences, such as White supremacy, discussed by Garcia et al. Yet, all institutions we examined were domestic institutions that were potentially being impacted by such external factors to a similar extent, and so should not impact our estimates significantly.

FINDINGS

Trends in 6-Year Graduation Rates for Latinx Students

Table 1 and Figure 1 illustrate the trends in 6-year graduation rates for Latinx students by institutional control and HSI status. We found that, between 2015 and 2017, the average 6-year graduation rates for Latinx students were steady, without any significant change. The rates, however, suddenly dropped in 2018 with greater changes among private institutions, which generally had higher 6-year graduation rates for Latinx students than public institutions had. We also discovered that, on average, private non-HSIs had the highest and public HSIs had the lowest 6-year graduation rates for Latinx students throughout the years.

Table 1. 6-Year Graduation Rates for Latinx Students: 2015–2018

	2015	2016	2017	2018
Public HSI	38.01	37.18	38.96	34.75
Private HSI	44.88	44.80	45.57	36.89
Public Non-HSI	41.50	41.91	41.03	36.80
Private Non-HSI	51.94	52.05	53.81	46.70

Differences in Institutional Characteristics between HSIs and Non-HSIs

As shown in Table 2, HSIs and non-HSIs appeared to have meaningful differences in their institutional characteristics. In terms of the outcome, HSIs, on average, had between 5 to 7 percentage points lower 6-year graduation rates for Latinx students than non-HSIs (e.g., 39.2% for HSIs and 45.9% for non-HSIs). This trend held for the years 2015 through 2018.

Figure 1. Latinx Student’s 6-Year Graduation Rates, 2015–2018

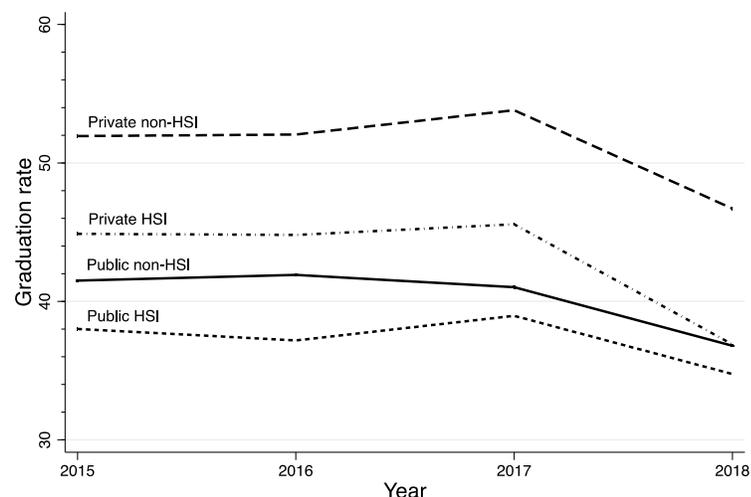


Table 2. Differences in Institutional Characteristics Between HSIs and Non-HSIs: 2015-2018

Variables	2015						2016						2017						2018						
	HSIs			Non-HSIs			HSIs			Non-HSIs			HSIs			Non-HSIs			HSIs			Non-HSIs			
	N	M.	S.D.	N	M.	S.D.	N	M.	S.D.	N	M.	S.D.	N	M.	S.D.	N	M.	S.D.	N	M.	S.D.	N	M.	S.D.	
Outcome																									
6-yr graduation rate+	96	44.1	15.8	1182	50.3	24.0	88	43.9	15.1	1195	50.8	23.0	107	46.1	16.3	1179	51.3	23.9	117	39.2	19.2	1184	45.9	22.7	
Student Body																									
% White+	101	29.5	14.3	1220	60.6	21.1	91	28.5	13.1	1223	59.6	21.1	109	28.9	13.3	1209	59.3	21.0	121	29.1	13.3	1204	58.8	21.0	
% Asian+	101	8.1	8.1	1220	3.2	5.1	91	6.7	7.1	1223	3.5	5.4	109	7.1	7.6	1209	3.5	5.3	121	6.8	7.2	1204	3.6	5.3	
% Black	101	10.0	8.3	1220	14.0	20.8	91	10.6	8.7	1223	13.7	20.2	109	10.8	8.8	1209	13.8	20.1	121	11.0	9.2	1204	13.9	20.1	
% Latinx+	101	38.4	15.8	1220	6.5	5.7	91	40.0	15.6	1223	7.2	6.7	109	38.7	15.1	1209	7.4	6.5	121	38.3	14.8	1204	7.7	6.6	
% Indigenous	101	0.5	1.2	1220	0.4	1.8	91	0.5	1.1	1223	0.4	1.8	109	0.5	1.0	1209	0.4	1.8	121	0.5	1.2	1204	0.5	1.8	
% Multiracial	101	2.3	1.9	1220	2.4	2.4	91	2.4	2.1	1223	2.6	2.4	109	2.6	2.2	1209	2.8	2.4	121	2.7	2.2	1204	3.0	2.5	
% Unknown	101	4.0	4.3	1220	5.3	6.8	91	4.5	5.0	1223	5.1	6.6	109	4.4	4.7	1209	5.0	6.8	121	4.3	4.1	1204	4.8	6.6	
% International	101	3.3	3.2	1220	3.8	4.8	91	2.9	2.5	1223	4.0	4.9	109	3.3	3.1	1209	4.0	4.8	121	3.2	2.9	1204	4.0	4.8	
Instructional Staff																									
% White+	101	66.8	12.4	1224	77.7	17.8	91	66.4	11.9	1227	77.1	17.6	109	66.2	12.9	1213	76.5	17.8	120	65.1	13.3	1208	75.8	18.0	
% Asian+	101	9.7	5.7	1224	5.7	4.7	91	8.9	5.5	1227	6.1	4.9	109	9.0	5.8	1213	6.3	5.1	120	9.3	6.2	1208	6.3	5.1	
% Black	101	4.0	3.2	1224	6.6	14.3	91	4.4	3.6	1227	6.7	14.3	109	4.5	3.4	1213	6.8	14.4	120	5.1	4.1	1208	6.9	14.4	
% Latinx+	101	11.2	11.2	1224	2.3	2.1	91	11.3	10.7	1227	2.5	2.3	109	10.3	9.3	1213	2.5	2.4	120	10.2	9.5	1208	2.6	2.4	
% Indigenous	101	0.3	0.5	1224	0.4	1.6	91	0.4	1.3	1227	0.3	1.0	109	0.4	1.1	1213	0.3	1.2	120	0.3	0.9	1208	0.3	1.2	
% Multiracial	101	0.7	1.4	1224	0.5	1.4	91	0.6	1.6	1227	0.5	1.4	109	0.6	1.0	1213	0.5	1.2	120	0.7	1.3	1208	0.6	1.2	
% Unknown	101	2.2	3.4	1224	2.1	6.0	91	2.4	3.9	1227	2.0	4.9	109	3.0	6.1	1213	2.1	5.2	120	3.3	7.3	1208	2.4	5.9	
% International	101	2.1	2.7	1224	1.9	3.2	91	2.5	3.3	1227	2.0	3.2	109	3.0	4.3	1213	2.0	3.1	120	2.9	3.9	1208	2.2	3.5	
Cost & Aid (unit: \$1K)																									
Cost of attendance+	89	31.9	12.3	1182	37.9	14.6	79	33.4	12.7	1185	38.9	15.2	98	35.3	12.7	1169	40.0	15.8	108	35.3	12.9	1165	41.2	16.4	
Average grant aid+	101	10.5	5.5	1220	14.5	8.5	91	11.0	5.9	1223	14.8	8.9	109	12.1	6.4	1209	15.4	9.3	121	12.4	6.8	1204	16.4	9.8	
Average loan	101	7.2	1.5	1219	7.2	1.1	91	6.9	1.6	1222	7.1	1.2	109	7.0	1.3	1208	7.1	1.2	121	7.0	1.5	1203	7.0	1.2	

Services/Support[^]

Remedial+	101	81.2	0.4	1225	65.8	0.5	91	79.1	0.4	1228	65.9	0.5	109	79.8	0.4	1214	64.9	0.5	121	80.2	0.4	1209	64.0	0.5
Counseling	101	100.0	0.0	1225	99.8	0.0	91	100.0	0.0	1228	99.9	0.0	109	100	0.0	1214	99.9	0.0	121	100.0	0.0	1209	99.9	0.0
Employment	101	97.0	0.2	1225	95.8	0.2	91	96.7	0.2	1228	96.0	0.2	109	97.2	0.2	1214	95.9	0.2	121	98.3	0.1	1209	96.1	0.2
Placement	101	83.2	0.4	1225	88.7	0.3	91	85.7	0.4	1228	88.6	0.3	109	86.2	0.3	1214	88.1	0.3	121	87.6	0.3	1209	87.7	0.3
Campus day care+	101	48.5	0.5	1225	27.6	0.4	91	49.5	0.5	1228	27.7	0.4	109	48.6	0.5	1214	27.1	0.4	121	46.3	0.5	1209	26.5	0.4
Library (physical)	101	99.0	0.1	1225	98.6	0.1	91	98.9	0.1	1228	98.9	0.1	109	99.1	0.1	1214	99.0	0.1	121	97.5	0.2	1209	99.4	0.1

Institutional Expense

% Instruction	100	42.6	8.1	1214	43.2	8.5	90	41.6	8.6	1224	42.6	8.7	108	41.4	8.8	1210	42.3	8.7	119	39.3	8.3	1199	41.7	8.8
% Research	100	3.8	7.6	1214	4.2	8.3	90	4.0	7.5	1224	4.1	8.1	108	3.7	6.9	1210	4.1	8.2	119	4.0	7.2	1199	4.1	8.1
% Public service	100	2.3	4.6	1214	2.4	4.2	90	2.4	4.8	1224	2.3	4.1	108	2.2	4.5	1210	2.3	4.2	119	2.0	4.3	1199	2.3	4.1
% Academic support	100	11.2	4.4	1214	10.7	4.6	90	11.0	4.8	1224	10.5	4.6	108	10.7	5.1	1210	10.6	4.6	119	10.4	4.5	1199	10.6	4.8
% Student service+	100	14.1	6.4	1214	16.1	8.0	90	14.0	6.7	1224	16.2	8.1	108	14.6	7.5	1210	16.4	8.2	119	14.3	7.9	1199	16.7	8.4
% Institution support	100	17.3	7.8	1214	19.4	8.0	90	18.0	8.3	1224	19.3	8.1	108	17.7	8.2	1210	19.3	8.1	119	17.4	8.8	1199	19.2	8.1

Other

Enrollment+ (unit: 1K)	101	11.1	11.1	1220	6.6	8.4	91	10.1	11.0	1223	6.8	8.6	109	10.2	11.4	1209	6.8	8.8	121	11.1	12.8	1204	6.6	8.5
% Admitted	100	67.5	19.3	1214	66.9	20.4	89	68.4	19.2	1217	66.4	20.3	109	68.5	21.8	1214	66.8	21.5	118	72.0	19.1	1192	67.8	21.0
% Private+	101	43.6	0.5	1225	63.6	0.5	91	46.2	0.5	1228	63.0	0.5	109	48.6	0.5	1214	63.0	0.5	121	47.1	1.0	1209	63.5	0.5
% Baccalaureate+	16	15.8	-	499	40.7	-	16	17.6	-	495	40.3	-	22	20.2	-	489	40.3	-	27	22.3	-	488	40.4	-
% Master's	66	65.4	-	495	40.4	-	57	62.6	-	501	40.8	-	67	61.5	-	495	40.8	-	70	57.9	-	495	40.9	-
% Doctoral	19	18.8	-	231	18.9	-	18	19.8	-	232	18.9	-	20	18.4	-	230	19.0	-	24	19.8	-	226	18.7	-

+ Variables with consistently significant difference (p < 0.05) between HSIs and non-HSIs throughout 2015 and 2018. T-tests and chi-squared tests were conducted for continuous and categorical variables, respectively.

[^] Mean values for categorical variables can be interpreted as relative frequencies.

The demographic makeup of the student body differed between HSIs and non-HSIs. As anticipated, HSIs had higher proportions of Latinx students than non-HSIs (e.g., 38.3% vs. 7.7% in 2018). The proportion of White students was substantially lower at HSIs, with 29.1% in 2018 versus 58.8% at non-HSIs. Moreover, the proportion of Asian students attending HSIs was also about twice the proportion as at non-HSIs (e.g., 6.8% at HSIs vs. 3.6% at non-HSIs in 2018). These differences were statistically significant between HSIs and non-HSIs throughout the years in our analysis. For other race/ethnic groups, including Black, Indigenous, multiracial, and international students, the proportions are approximately the same at HSIs and non-HSIs.

HSIs also differed from non-HSIs in their racial and ethnic composition of the full-time instructional staff, with smaller proportions of White instructors (e.g., 65.1% at HSIs compared to 75.8% at non-HSIs in 2018). HSIs had a higher proportion than non-HSIs of instructors who were Latinx (10.2% at HSIs vs. 2.6% at non-HSIs in 2018) and a higher proportion of Asian instructors (e.g., 9.3% at HSIs compared to 6.3% at non-HSIs in 2018). Other demographic groups, including Black, Indigenous, and international, were equally represented among instructional staff at HSIs and non-HSIs, as were instructors of unknown race/ethnicity. These trends held throughout the years we examined.

HSIs were also distinct from non-HSIs in their financial aid profile. The average cost of attendance was higher at non-HSIs than at HSIs by about \$5,000 to \$7,000. However, this was offset by differences in grant aid for enrolled students: non-HSIs offered higher grant aid awards than HSIs (e.g., \$16,400 at non-HSIs compared to \$12,400 at HSIs in 2018), with statistical significance between years 2015 and 2018.

When examining student support services, we observed that HSIs offered more services accommodating nontraditional and adult learners. While nearly half of HSIs reported having on-campus day-care services for students with young children, only about one fourth of non-HSIs in our sample provided campus day care. This difference was statistically significant throughout all years. HSIs also had more remedial offerings, with around 80% of these institutions providing remedial courses, compared to about 65% of non-HSIs. Moreover, non-HSIs reported spending a greater proportion of core institutional expenses on student services than did HSIs. However, among other types of services, we observed similarities between HSIs and non-HSIs: student counseling services, employment services, and campus libraries were nearly universal among both HSIs and non-HSIs. More than 80% of campuses offered placement services for graduating students, with no significant differences between HSIs and non-HSIs.

We also found several differences between the sector and size of HSIs compared to non-HSIs. HSIs were larger on average, enrolling about 5,000 more students at each campus than the non-HSIs in our sample enrolled. While the majority of non-HSIs in our sample were private colleges and universities (63.5% in 2018), fewer than half of HSIs were private (47.1%). The level of degree offerings also differed between HSIs and non-HSIs. HSIs included fewer baccalaureate degree-granting institutions but more master's degree-granting institutions, when compared to non-HSIs.

Institutional Characteristics and 6-Year Graduation Rates for Latinx Students

Table 3 presents the findings from the panel analysis of the relationship between institutional characteristics and Latinx students' 6-year graduation rates for (a) all institutions, (b) HSIs only, and (c) non-HSIs only. The first column reports the estimates for the full population of colleges and universities in our sample. We found that HSI status of an institution was not a statistically significant predictor of Latinx students' 6-year graduation rate, all else being equal. However, among the other institutional characteristics, student demographic characteristics and institutional services offered were predictive of the Latinx graduation rate.

For each additional percentage-point increase in the proportion of multiracial students, the 6-year graduation rates for Latinx students decreased by 0.83 percentage points, controlling for all other covariates. Among the student services offered, both remedial classes and academic/career counseling were predictive of lower Latinx graduation rates, with the provision of remedial services associated with a 5.12 percentage points lower Latinx students' 6-year graduation rate, holding all else constant, and academic counseling associated with a 22.73 percentage points lower rate. Career placement services were predictive of higher Latinx students' 6-year graduation rates, with this student service offering associated with 5.04 percentage points higher rate, all else equal.

Table 3. Panel Analysis Results (Outcome: 6-Year Graduation Rates for Latinx Students)

Variables	All		HSIs		Non-HSIs	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
HSI status	-1.54	(1.44)				
Student body						
% White	-0.07	(0.31)	-0.61	(0.60)	-0.10	(0.33)
% Asian	0.75	(0.51)	-0.88	(0.82)	0.91	(0.56)
% Black	0.05	(0.36)	-0.03	(0.77)	0.03	(0.39)
% Latinx	-0.02	(0.34)	-1.06*	(0.57)	-0.04	(0.40)
% Native	1.05	(1.11)	-1.90	(1.70)	1.46	(1.24)
% Multiracial	-0.83*	(0.45)	-1.24	(1.08)	-0.76	(0.47)
% Race unknown	0.17	(0.32)	-0.88	(0.56)	0.15	(0.34)
% International	-0.09	(0.34)	-1.22*	(0.65)	-0.08	(0.37)
Instructional staff						
% White	-0.34	(0.28)	-0.23	(0.65)	-0.32	(0.31)
% Asian	-0.08	(0.34)	0.64	(0.71)	-0.15	(0.37)
% Black	-0.51	(0.35)	0.43	(0.82)	-0.48	(0.37)
% Latinx	-0.37	(0.37)	-0.46	(0.66)	-0.34	(0.43)
% Native	-0.41	(0.46)	-0.33	(0.87)	-0.39	(0.48)
% Multiracial	0.00	(0.33)	-0.60	(0.68)	0.04	(0.36)
% Race unknown	-0.25	(0.28)	-0.61	(0.64)	-0.22	(0.30)
% International	-0.39	(0.30)	0.01	(0.61)	-0.45	(0.33)
Cost & aid (unit: 1K)						
Cost of attendance	0.06	(0.18)	-0.36	(0.28)	0.11	(0.20)
Average grant aid	-0.02	(0.19)	0.20	(0.35)	-0.07	(0.20)
Average loan	-0.15	(0.44)	0.24	(0.45)	-0.19	(0.48)

Services/support

Remedial	-5.12*	(2.83)	-23.00***	(2.92)	-4.85	(3.01)
Academic/career counseling	-22.73**	(9.49)	-	-	-23.59**	(9.66)
Employment services	0.93	(9.29)	-	-	0.67	(9.42)
Placement services	5.04***	(1.91)	-0.90	(3.08)	5.84***	(2.06)
On-campus day care	-0.13	(2.55)	-2.06	(1.63)	-0.14	(2.83)
Library	-6.71	(5.47)	-	-	-7.47	(5.81)

Institutional expense

% Instruction	-0.25	(0.33)	0.64	(0.53)	-0.34	(0.36)
% Research	-0.20	(0.36)	1.11*	(0.59)	-0.32	(0.39)
% Public service	-0.03	(0.42)	-0.27	(0.70)	0.06	(0.46)
% Academic support	0.37	(0.37)	1.85***	(0.58)	0.26	(0.40)
% Student service	-0.21	(0.36)	0.24	(0.64)	-0.24	(0.39)
% Institution support	0.09	(0.33)	0.93*	(0.54)	0.03	(0.36)
% Other	-0.06	(0.33)	0.73	(0.54)	-0.12	(0.36)

Other

Enrollment (unit: 1K)	-0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)
Selectivity (% admitted)	0.06	(0.04)	0.04	(0.06)	0.06	(0.05)
Year 2016 (reference: 2015)	0.46	(0.63)	1.44	(1.05)	0.35	(0.67)
Year 2017	1.12	(0.79)	3.70**	(1.78)	0.90	(0.84)
Year 2018	-4.43***	(0.97)	-1.92	(2.95)	-4.63***	(1.03)
Constant	119.22**	(51.47)	79.85	(96.81)	127.27**	(55.57)
Observations	4,968		371		4,597	
R-squared (within)	0.04		0.34		0.04	
Number of institutions	1,266		117		1,189	

*** p < 0.01, ** p < 0.05, * p < 0.1

Note: In the analysis of the subsample of HSIs, omitted variables occur because they are time-invariant in this group.

Among the sample of HSI institutions only, we found marginally significant estimates among student demographic characteristics. Each additional percentage point of Latinx student enrollment was associated with about 1 percentage point lower 6-year graduation rate, holding all else constant; the same was true of each additional percentage point of international student enrollment. For the indicator variables of student and support services, we found that provision of remedial services was associated with 23 percentage points lower Latinx students' 6-year graduation rate, holding all else constant.

We also found that institutional expenditures were predictive of Latinx students' 6-year graduation rates. Higher 6-year graduation rates were marginally associated with higher spending on research and institutional support (i.e., executive-level administration, legal, and fiscal operations) and on central facilities and space management. Spending on academic support was associated with higher Latinx students' 6-year graduation rates, with each additional percentage point of spending predicting 1.85 percentage points higher graduation rates, holding all else constant.

We discovered that the relationship between institutional characteristics and Latinx students' 6-year graduation rates at HSIs appeared to be different among non-HSIs. Among non-HSIs, only several student services and support provisions were related to Latinx students' 6-year graduation rates. All else being equal, an offering of academic counseling was associated with 23.59 percentage points lower 6-year graduation rate for Latinx students, while career placement services were positively associated with Latinx students' 6-year graduation rates, with 5.84 percentage points higher rate for each additional percentage point increase, all else equal.

DISCUSSION AND CONCLUSION

The primary goals of this study were to better understand the meaning of servingness in the context of HSIs and to determine the extent to which HSIs serve Latinx students in terms of their 6-year degree attainment at not-for-profit 4-year institutions. Using a multidimensional conceptual framework of servingness proposed by Garcia et al. (2019), we defined our outcome and the key institution-level factors that could be associated with the outcome. We first examined trends in 6-year graduation rates for Latinx students from 2015 to 2018; findings showed that public HSIs had the lowest 6-year graduation rates for Latinx students over the years while private non-HSIs had the highest rates. More broadly, public institutions (both HSIs and non-HSIs), on average, had lower 6-year graduation rates for Latinx students than private institutions. By HSI-designation status, even after accounting for all other characteristics, the average Latinx students' 6-year graduation rates were significantly lower for HSIs than for non-HSIs.

Moreover, Latinx students' 6-year graduation rates were generally lower than 50% at private HSIs, public HSIs, and public non-HSI institutions from 2015 to 2017, while private non-HSIs had graduation rates slightly higher than 50%. Our overall findings (i.e., below 50%) were consistent with previously reported rates (e.g., Contreras & Contreras, 2015; Perez, 2020). Intriguingly, we also observed that 6-year graduation rates for Latinx students suddenly decreased in 2018 compared to previous years for all types of institutions regardless of HSI status or institutional control. We assumed that there could have been an external influence on institutions' capacity to serve Latinx students. For instance, in September 2017 the U.S. Department of Homeland Security issued a memo, "Memorandum on Rescission of Deferred Action for Childhood Arrivals (DACA)," announcing the government's intention to wind down the DACA program. According to Garcia et al. (2019), political or legal contexts can influence institutions' ability to serve Latinx students. Future research is needed to examine whether these types of changes in institutions' external policy environment have long-term consequences for serving Latinx students in higher education institutions.

We further delved into understanding the similarities and differences between HSIs and non-HSIs regarding the organizational environment that impacts student experiences (e.g., Latinx percentage of student body) and, moreover, how these institutional characteristics were associated with Latinx students' 6-year graduation rates. Our results demonstrated that HSIs had significantly larger proportions of Asian and Latinx students and lower proportions of White and Black students than did non-HSIs. In particular, the percentage of Latinx students at HSIs was nearly 5.4 times higher than at non-HSIs. However, all else being equal, the

ratio of Latinx students had a marginally significant and negative impact on Latinx students' 6-year graduation rates at HSIs. Although previous scholars have emphasized the importance of student experiences with same-race or same-ethnicity peers (Garcia et al., 2019), our result suggests that peer effects might not apply in the same way for this outcome, although we did not examine other academic outcomes such as grades or retention. The data in our analysis do not show a statistically meaningful relationship between the proportion of Latinx students and their 6-year graduation rates at non-HSIs. This might be attributable to the fact that non-HSIs have a much lower proportion of Latinx students, which limits the impact of Latinx student body on Latinx student outcomes.

HSIs had a significantly higher percentage of Latinx instructional staff (about 4.8 times higher) than non-HSIs. However, contrary to expectations, the proportion of Latinx instructional staff did not have a significant association with Latinx students' 6-year graduation rates either among students at HSIs or in the full sample. While prior studies (e.g., Hurtado et al., 2015) showed that a representative faculty could have positive effects on Latinx student outcomes, our findings suggest that, at HSIs with a large proportion of Latinx peers, a larger proportion of Latinx instructional staff might have a limited contribution to Latinx students' 6-year graduation rate. This result could show the nuances of validating experiences for Latinx students (Garcia et al., 2019). Latinx students at HSIs may find more profound validating experiences through peer interactions than through staff interaction because the former interactions occur more frequently.

Using Garcia et al.'s (2019) framework of servingness, this study also focused on the impact of institutions'

structural capacity (e.g., institutional expenditures and student services) to serve Latinx students. We investigated student services offerings, financial aid, and institutional expenses at HSIs and non-HSIs, and analyzed how these factors were associated with Latinx students' 6-year graduation rates. We discovered that a greater proportion of HSIs offered remedial education, employment services, and on-campus day care than did non-HSIs, and that the average cost of attendance was covered by higher percentages of Pell Grants and loans at HSIs than at non-HSIs. The offering of remedial services was a significant and substantively large predictor of lower Latinx graduation rates in both the HSI institutions and in the full sample. However, this was not a causal effect in which remedial services led to poorer academic outcomes. Instead, this likely reflects the fact that institutions serving students with high levels of need for academic support are both more likely to offer remedial support and more likely to have lower graduation rates for all students. Among the other student services, for the full sample we also found that academic/career counseling was associated with lower Latinx students' 6-year graduation rates, while placement services were associated with higher rates, a finding that was consistent for the non-HSI sample. Career placement services could increase students' motivation to complete their degrees, given the promise of gainful employment awaiting them after graduation.

HSIs' expenses on instruction, research, student services, and institutional support also accounted for significantly lower percentages of the total institutional expense than non-HSIs. Our findings demonstrated that HSIs were distinguishable from non-HSIs in various aspects such as the types of student support (i.e., types of student need) or institutional spending emphasized by

institutions; in addition, our findings highlighted that it is inappropriate to compare the two types of institutions without context (Rodriguez & Calderón Galdeano, 2015). In terms of the predictive capacity of institutional spending measures, we found that additional spending on research and academic support was associated with higher Latinx students' 6-year graduation rates at HSI institutions; that was not the case in the overall sample. Overall, we conclude that these structural features are generally associated with institutional selectivity as well as with the financial capacity to provide an academic environment and support for student success; these features have an important impact on Latinx students' 6-year graduation rates at 4-year institutions.

In summary, framing servingness at HSIs as an organizational and structural issue allows for focus on institutions as the unit of analysis to identify needs for strengthening their capacity to serve Latinx students (Garcia, 2017, 2019; Garcia et al., 2019). To that end, leaders, decision makers, and policymakers must be clear in their words and actions about what it means to serve Latinx students and to identify the types of resources needed for their success (Garcia, 2019; Vargas & Villa-Palomino, 2019). For instance, securing financial resources such as federal or state funding to support Latinx

students should continue to be a key focus for institutional leaders. Moreover, such support should result in greater capacity for serving Latinx students to improve and sustain positive academic and nonacademic student outcomes (Garcia et al., 2019; Perez, 2020; Vargas et al., 2020). Namely, HSIs must recognize that these students are the reason why institutions are designated as such and why they are eligible for targeted federal funding (Vargas & Villa-Palomino, 2019).

Future research should continue to build on existing empirical evidence to understand how HSIs are evolving due to their defining characteristics of Latinx student enrollment and how such changes are impacting institutional capacity to serve Latinx students. Longitudinal studies can particularly highlight how HSIs are contributing to the overall higher education ecosystem. As colleges and universities look to find novel ways to increase enrollment and graduation rates for underrepresented students, research that continues to examine the types of institutional characteristics can uncover trends and patterns that could contribute to institutional success. It is imperative that studies continue to investigate which characteristics of HSIs contribute to the success of Latinx students in particular, and how and why these characteristics matter.

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Examining Factors That Influence BIPOC Students' Enrollment in STEM Postsecondary Majors

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Abstract

Existing research has studied the underrepresentation of Black, Indigenous and People of Color (BIPOC) students enrolling in and graduating from science, technology, engineering, and mathematics (STEM) fields in college (e.g., Okahana et al., 2018; Rincón & Lane, 2017). However, there is a dearth of research that examines the precollegiate factors that impact whether a student majors in a STEM field (Moakler & Kim, 2014). This study uses binary logistic regression and moderated binary logistic regression to examine the influences that gender, mathematics (math) identity, science identity, career expectations at age 30, and high school STEM credit completion have on BIPOC students' postsecondary major (STEM or non-STEM). Based on the logistic regression results, our study indicates that gender, science identity, career expectations at age 30, and high school STEM credit completion significantly predict the odds of postsecondary enrollment in a STEM

major. In addition, our ad hoc analysis confirms that gender moderates the relationship between science identity and the likelihood of a STEM collegiate major. These results can aid researchers and practitioners in investigating opportunities to improve STEM participation for BIPOC students.

Keywords: STEM identity; STEM career expectation; math and science credit completion; STEM enrollment

INTRODUCTION

A robust body of research emphasizes how science, technology, engineering, and mathematics (STEM) education settings are often unwelcoming to minoritized students (Bang & Medin, 2010; Martin, 2013; McGee, 2021), including female students and Black, Indigenous, and People of Color (BIPOC) students. Research illuminates how STEM opportunities are uneven across different identity groups (National Center for Science and Engineering Statistics [NCSES], 2019). While BIPOC students are equally likely to show interest in and to choose STEM majors when they enter college compared to their White peers (Beasley & Fischer, 2012; Ma & Xiao, 2021), there remains the concern for underrepresentation during their persistence along the STEM pathways, including whether they will choose a STEM major (Chang et al., 2014; Foltz et al., 2014; Moakler & Kim, 2014), complete a STEM degree (Foltz et al., 2014; Rincón & Lane, 2017), and participate in the STEM workforce (NCSES, 2019). Various studies document BIPOC students' experiences of feeling invisible and excluded, unevaluated, underrecognized, and marginalized in STEM (Malone & Barrabino, 2009; Morton & Parsons, 2018; Nasir & Vakil, 2017). Using the High School Longitudinal Study of 2009 (HSL:09) (National Center for Education Statistics [NCES], 2009) data set, the current study examines the influences that gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion have on BIPOC students' postsecondary major (STEM or non-STEM). Our study contributes to emerging quantitative research that centers on the experiences of underrepresented students in STEM disciplines.

LITERATURE REVIEW

In this section we analyze the literature that discusses BIPOC students' persistence in STEM majors, STEM identity, sense of belonging, high school math and science credit completion, and STEM career expectation to articulate the potential influences of these components. We elaborate each of these components.

BIPOC Students' Persistence in STEM Majors

BIPOC students' persistence in STEM majors is portrayed in the literature through discussions on the structural inequities that constrict those students' access to STEM (Hubbard & Stage, 2009; National Science Foundation [NSF], 2017), participation (Boucher et al., 2017; Foltz et al., 2014), completion (Okahana et al., 2018), and thus representation (NCSES, 2019) in both STEM college majors and in the STEM workforce. Wang (2013) presented an interconnected web of variables that provide the context for when a high school student persists through and majors in a postsecondary STEM program. Wang's study highlighted strong impacts of 12th-grade math achievement, exposure to math and science resources, as well as the impact that math self-efficacy beliefs have on students' intent to major in STEM. When examining the precollegiate variables, the author observed how these interrelated factors occur differently by race and indicated a stronger presence of desirable academic outcomes related to majoring in STEM for White students than for BIPOC students.

The literature focusing on BIPOC students' persistence in STEM highlights efforts and characteristics of those who are retained in STEM and who are experiencing success (Chang et al., 2014; Covington et al., 2017; Foltz et al., 2014). This research highlights a range of supportive factors, including (1) familial expectations and supports (Ceglie & Settlege, 2016; Dotterer, 2022; Foltz et al., 2014); (2) high school academic preparation (Griffith, 2010; Palmer et al., 2011); (3) out-of-school STEM-related activities (Taylor, 2019); (4) participation in undergraduate research and presence of collegiate faculty support (Chang et al., 2014; Estrada et al., 2018; Foltz et al., 2014); (5) STEM involvement with peer groups, academic clubs, or organizations (Chang et al., 2014); (6) financial aid (Foltz et al., 2014); and (7) self-efficacy and self-beliefs about the STEM discipline (Carpi et al., 2017; McClure et al., 2007).

STEM Identity

Research from the field of psychology has situated understandings of how an individual develops identities as an internal, cognitive process (Cote & Levine, 2002; Erikson, 1968). Meanwhile, sociological perspectives focus on social interactions—encompassing roles, structures, and practices—leading to the formation of one's identity (Weigert, 1986). The notion of STEM identity connects closely to these theoretical viewpoints, and explores self-concept as suitable for a STEM discipline and/or career. It is, however, important to note that there has been a shift from research that views STEM identity as an assumed, stable characteristic to one that examines the different trajectories of identification (Nasir & Cooks, 2009; Nasir & Hand, 2008; Polman, 2012) in which students relate with STEM both academically (Nasir, 2011)

and professionally (Ong et al., 2018) across time and space. This literature depicts numerous self-concepts and values (Avraamidou, 2020; Hazari et al., 2010;) and carefully examines the embedded sociocultural contexts to better understand various ways that learners negotiate and transform their STEM learning (Morton & Parsons, 2018; Nasir et al., 2020; Tran et al., 2023; Wortham, 2004).

Sense of Belonging

Malone and Barrabino (2008) articulated a prominent issue in STEM education settings, in which BIPOC students experience being the only minority student in their classes. The authors emphasized the racialization of identity in which BIPOC students are not recognized as possessing relevant traits, rights, and obligations as scientists. Racialization of identity is associated with (1) students' experiences of isolation, (2) interactions that emphasize the salience and disapproval of their racial identities, (3) and struggles for recognition of their knowledge and disposition in the fields. Being *the only one* is among numerous equity issues (see Carlone et al., 2011; Miller et al., 2006; Strayhorn et al., 2013) repeatedly experienced by minority students, despite their desire and agency to explore and transform STEM education (Miller et al., 2018). This relates to students' sense of belonging—in other words, to their connection with the discipline, which is integral to their decision to either stay in or leave STEM majors (Chen et al., 2020; Rainey et al., 2018). An ample body of research documents the lack of sense of belonging among BIPOC students in their STEM majors as compared to White and Asian counterparts (Rainey et al., 2018), noting this pattern exacerbates even more among BIPOC women in STEM (see Dortch & Patel, 2017; Jong et al., 2020; Morton & Parsons, 2018).

The development of STEM identity has been largely supported in the literature by its relations to sense of validation; knowledgeability (Carlone & Johnson, 2007; McDonald et al., 2019; Seyranian et al., 2018); and engagement, persistence, and matriculation (Aschbacher et al., 2010; Estrada et al., 2018). There is profound research that details factors that challenge and/or support BIPOC students in particular and underrepresented students in general throughout their STEM identity development (Carlone & Johnson, 2007; A. Johnson et al., 2011; Jong et al., 2020). In particular, this literature connects STEM identification processes with support and recognition by family, peers, and educators (Collins & Roberson, 2020; Russell & Atwater, 2005), together with meaningful, validating experiences in different STEM learning environments and communities (Carpi et al., 2017; Lane, 2016; Morton & Parsons, 2018; Rodriguez et al., 2019; Tran et al., 2023).

High School Math and Science Credit Completion

The literature repeats racial disparities in math and science preparation (Strayhorn et al., 2013; Tyson et al., 2007); studies describing the trajectories of BIPOC students in STEM fields find that math and science courses they take before starting college are relative to discipline disposition and future advanced performance (Young et al., 2017), test scores achievement (Anderson, 2016), career interests (Sadler et al., 2014), and college persistence (Foltz et al., 2014). Fouad and Santana (2017) conducted a meta-analysis of factors influencing choices, decision, and barriers experienced by female and BIPOC students in STEM disciplines, calling attention to their math and science preparation and success in middle and early high school levels. With strong

evidence connecting STEM preparation, identity, engagement, and career pathway (Anderson, 2016; Palmer et al., 2011; Sadler et al., 2014; Wang, 2013; Young et al., 2017), engagement in high school math and science courses could provide key opportunities for BIPOC students to explore STEM interests and to strengthen a sense of efficacy from an early age.

STEM Career Expectation

STEM career expectation and aspiration are associated with positive learning attitude and interest (Nugent et al., 2012); identification (Hazari et al., 2010); as well as decidedness, goal clarity, and productive engagement in the career process (Goff et al., 2020). At the K–12 level, Mau and Li (2018) drew data from the HSLs:09 (NCES, 2009) sample to examine characteristics influencing whether a high school student aspires to pursue STEM careers by the time they are 30 years old. This study determined that race, gender, socioeconomic status, math interest, and science self-efficacy are the most important factors for determining a student's aspiration for a career in STEM. At the college level, Mau et al. (2016) maintained that there were significant gender and racial differences in how students make the decision whether to pursue STEM careers. Interestingly, Carpi et al. (2017) described the design of an undergraduate research program in a minority-serving institution, one that encouraged students to explore and reflect on their potential to persist as a STEM professional. The authors reported that students' participation in the program yielded increased experience, skills, and career ambition in STEM.

Our literature review repeats the existing discussion concerning racial disparities and inequities in STEM disciplines. This review allows us to further our

critical, quantitative, and large-scaled investigation on the multileveled factors and mechanisms influencing the enrollment and persistence of BIPOC students in postsecondary STEM majors.

METHODS

Researcher Positionality

All authors of the current study enrolled in the Spring 2021 National Center for Education Statistics (NCES) Data Institute to gain knowledge of NCES databases and to learn how federal data are archived and used from K–12 through postsecondary education settings. Out of 34 attendees, the five authors of this study were grouped based on our shared interest in STEM education. In our first group meeting, all team members made clear a shared orientation with critical theories, a shared positionality for social justice, and a shared interest in engaging in research that centers the competence and agency of historically minoritized students. During our weekly meetings, we engaged in conversations that recognized structural racism and sexism in the United States' educational system in general and in STEM disciplines in particular, and identified how such systemwide marginalization in many ways results in the underrepresentation and othering of historically minoritized students. Benefiting from the interdisciplinary characteristic of our team (whose interests and expertise include Learning Sciences and Human Development, Mental Health and Well-Being in Higher Education, Educational Measurement and Statistics, Equity, and Inclusion in Higher Education), we unpacked various examples relating to how data and methods are not neutral, and how quantitative data and methods are often

used to reinforce deficit worldviews on students who are not identified as heterosexual White men. While acknowledging limitations and constraints that bar us from fully recognizing and honoring the identity, diversity, and agency of BIPOC students in STEM disciplines, we are committed to providing a timely example for how large-scale quantitative analysis can be conducted in the way that distinguishes sociohistorical contexts embedded in the learning and dispositions of students throughout their STEM learning efforts.

We acknowledge that our study and its findings are not neutral. On the contrary, our decision making—which involved (1) brainstorming and crafting the research question; (2) reviewing the literature; (3) selecting the data set, sample of interest, and model for analysis; and (4) cleaning and manipulating data—was profoundly influenced by the named theoretical orientation and positionality, as well as by researchers' personal and professional factors. For example, to decenter whiteness and to avoid an improper methodological approach that compares White and non-White students without considering and adjusting for broader social historical context (Rios-Aguilar, 2014), we limited our sample to only BIPOC students.

Data Set, Sample, and Coding

We examined nationally representative longitudinal data from the HSL5:09 (NCES, 2009). The HSL5:09 originally surveyed more than 24,000 students who were selected from a nationally representative sample of 944 U.S. high schools. Also invited to complete surveys were those students' parents, math and science teachers, and counselors. The surveyed schools were public (including charter), private, and Catholic. The first survey was done

in 2009, with two follow-up surveys in 2012 and 2016. Our sample specifically consists of all BIPOC students in the HSLs:09 data set, which included 5,702 participants in the final analysis across the three years: 2009, 2012, and 2016. BIPOC students included those identified as Hispanic; Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian or Other Pacific Islander; and Other Race or Multiracial. Oversampling the subgroups was used to allow for adequate reporting by race or ethnicity (Ingels et al., 2013). The percentages of the population, while oversampled, were still consistent with the distribution of the U.S. population of students in 2009 based on data from the National Center for Education Statistics (NCES, 2022), which indicate that 1% of the school-age population were American Indian or Alaska Native, 5% were Asian, 17% were Black or African American, and 22% were Hispanic. Native Hawaiian or Other Pacific Islander and individuals from two or more races were not reported by all states and were thus excluded from the 2009 report. As shown in Table 1, 51.8% of students in our sample identified as female and 48.2% identified as male. For the breakdown

of race or ethnicity, the majority of our sample identified as Hispanic (45.5%), followed by Black or African American (28.3%). See Table 1 for details.

All students included in the study were enrolled in the 9th grade during the fall term of 2009. We used variables for this study from the baseline year (2009), the first follow-up year (2012), and the second follow-up year (2016); students were thus in Grade 9, in their first year of college, and in their fourth year of college, respectively, during the period of data collection. HSLs's variables included in this investigation are as follows:

- 1| Gender¹ (X2SEX)
- 2| Race or ethnicity (X2RACE)
- 3| Expected STEM occupation at age 30 (X4OCC30STEM1)
- 4| STEM first major (X4RFDGMJSTEM)
- 5| STEM credits taken in high school (X3TCREDSTEM)
- 6| Math identity (X2MTHID)
- 7| Science identity (X2SCIID)

Table 1. Distribution of Sample by Gender and by Race or Ethnicity

Variable	Category	N	Percent
Gender	Female	2,954	51.8
	Male	2,748	48.2
Race or Ethnicity	American Indian or Alaska Native	83	1.5
	Asian	418	7.3
	Black or African American	1,611	28.3
	Hispanic	2,596	45.5
	More than one race	937	16.4
	Native Hawaiian or Other Pacific Islander	57	1.0

1. The HSLs:09 survey structured gender identity questions into a two-staged process. In the baseline and first follow-up surveys, students were asked to report their sex at birth. Current gender identity (with more than two options) was asked in the second follow-up survey.

Prior to conducting the statistical analysis, the career expectations variable was recoded into STEM² and non-STEM options, and the remaining data were considered missing. Hispanic ethnicity was recoded by combining “Hispanic,” “no race specified and Hispanic,” and “race specified and Hispanic.” We used categories as they were originally classified in the HSLs:09 (NCES, 2009) survey for gender (i.e., male and female) and race or ethnicity. For the STEM first major variable (X4RFDGMJSTEM), we excluded the college students who indicated “Don’t know” for their major. Those who included their first major (some students indicated more than one major) as STEM and non-STEM were already coded in the HSLs:09 data set so they were analyzed as-is. For the expected variable of STEM occupation at age 30 (X4OCC30STEM1), the original data were divided into a non-STEM category and several different major STEM categories and then combined by the researchers to create one STEM variable. The STEM credits taken in high school variable (X3TCREDSTEM) was numeric and ranged from 0 to 16 credits as was

left as it was originally coded in the HSLs:09 data set. Math identity (X2MTHID) and science identity (X2SCIID) were preserved as they were in the original HSLs:09 data set where they were presented by z score values. Specifically, students reported a math identity and a science identity measure, where the converted z score of 0 was indicative of moderate math identity and science identity, respectively. Scores above and below $z = 0$ were indicative of higher-than-average math identity or science identity and lower-than-average math identity or science identity, respectively.

Descriptive Results

Our descriptive analysis provides insights into students represented in our sample and their perceptions on STEM involvement throughout high school and college (see Tables 1, 2, and 3). Descriptive information regarding STEM identity perceptions, career expectations, completed STEM credits in high school, and postsecondary major

Table 2. Math Identity, Science Identity, and STEM Credits Earned for BIPOC Students

Variable	Mean	SD	Minimum	Maximum	N
Math Identity	.01	.99	-1.54	1.82	5,702
Science Identity	-.05	.97	-1.74	1.86	5,702
STEM Credits Earned	7.0	3.0	0.00	16.00	5,702

Table 3. Expected STEM Occupation at Age 30 and STEM First Major for BIPOC Students

Variables	Category	N	Percent
Expected STEM Occupation at Age 30	Non-STEM	2,133	62.1
	STEM	1,301	37.9
STEM First Major	Non-STEM	3,106	79.9
	STEM	781	20.1

2. The six STEM categories, including (1) Life and Physical Science, Engineering, Mathematics, Information Technology; (2) Social Science; (3) Architecture; (4) Health, (5) expected occupation split across two STEM-related occupations (not specified); as well as (6) STEM occupation with no specificity, were combined into the one STEM category.

(STEM or non-STEM) were also examined (see Tables 2 and 3). BIPOC students reported approximately an average identification with math ($M = .01, SD = .99$).³

BIPOC students reported a little less than average identification with science ($M = -.05, SD = .97$). For high school completion of STEM credits, BIPOC students on average completed approximately seven STEM credits ($M = 7.02, SD = 2.99$). At 30 years old, 37.9% of BIPOC students expected to be in a STEM occupation. Finally, once BIPOC students entered postsecondary education, 20.1% reported majoring in STEM.

Correlation Analysis

A correlational analysis was conducted to assess the association between demographic data, the independent variables, and the dependent variable of the study (see Table 4). The majority of the correlations were positive associations and statistically significant. Given the large sample size, the statistical significance was not surprising, but since r is already a measure of effect size, we focused on the r values to determine practical significance in addition to statistical significance. Our

correlation analysis showed that strong associations did not exist between any of the variables. According to Cohen (1992), r values that are less than .30 indicate small effect sizes. As shown in Table 4, the positive and statistically significant correlations were relatively weak, with r values ranging from .01 to .28. Similarly, the negative and statistically significant correlations ranged from -0.01 to -0.19 . This suggested that multicollinearity was not an issue in our sample, meaning predictor variables were not necessarily related in explaining the dependent variable—students' postsecondary enrollment in a STEM major. It is worth noting that, while all variables were statistically significantly associated with postsecondary enrollment in STEM majors, the weak association suggests that there may be confounding factors that were not measured in this study, factors that have more influence on students' choices to enroll in a STEM major.

Data Analysis

Our research question is, "Does gender, science and math identity, career explorations, and high school STEM credit completion influence BIPOC students' postsecondary enrollment in a STEM major?" For

Table 4. Correlations between Study Variables

	1.	2.	3.	4.	5.	6.
Gender	—					
Math Identity	-0.06	—				
Science Identity	0.01	0.20	—			
Career Expectations at Age 30	0.20	0.13	0.22	0.13	—	
High School STEM Credit Completion	-0.01	0.14	0.12	—		
Postsecondary Major (STEM or non-STEM)	-0.19	0.17	0.26	0.16	0.28	—

3. Mathematics and science identity were standardized to have a mean of 0 and a standard deviation of 1.

data analysis, we examined descriptive statistics for each variable. We first conducted a correlational analysis to assess any associations between the variables of interest (i.e., gender, math identity, science identity, career expectations at age 30, high school STEM course completion, and postsecondary major [STEM or non-STEM]). We then tested the logistic regression assumptions and conducted a binary logistic regression analysis correspondingly. Specifically, we examined whether the predictor variables, including gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion, can successfully predict a student’s postsecondary major (STEM or non-STEM). We used binary logistic regression because the dichotomous and continuous predictors were predicting a dichotomous outcome variable. As a follow-up based on the results of the binary logistic regression, we included gender as a moderator to determine whether gender moderates such relationships.

RESULTS AND INTERPRETATION

The HSL:09 (NCES, 2009) data set is not a simple random sample of U.S. high school students; specifically, it used a stratified, two-stage random sample design. As a result, analytic weights were

included in the data set to ensure the sample data was representative of the population of high school students due to the differential response rates in the sample (Ingels et al., 2013).

Binary Logistic Regression

A binary logistic regression was conducted to examine the relationship between gender, math identity, science identity, career expectations at age 30, high school STEM credit completion, and postsecondary major (STEM or non-STEM) (see Table 5). The overall model was statistically significant ($\chi^2(5) = 129.62, p < .001$) with a small effect size ($R^2 = .20$). Gender significantly predicted the likelihood of postsecondary enrollment in STEM major ($\text{Exp}(B) = .24, p < .001$). The odds of female students enrolling in a postsecondary STEM major were .76 less than the odds of male students so enrolling. In other words, female students were less likely to enroll in STEM majors compared to male students. Science identity significantly predicted the likelihood of postsecondary enrollment in STEM majors ($\text{Exp}(B) = 1.66, p < .001$). For each standard deviation increase in science identification, BIPOC students had approximately 1.7 times greater odds of majoring in STEM. This result confirms that BIPOC students who “identified more as a STEM person” were more likely to major in STEM. STEM credits

Table 5. Binary Logistic Regression of Demographic and High School Variables Predicting College Major

Source	Odds Ratio	SE	p	95% CI OR
Intercept	0.10	0.05	.000	[0.04, 0.25]
Gender	0.24	0.06	.000	[0.15, 0.39]
Math Identity	1.24	0.23	.252	[0.86, 1.77]
Science Identity	1.66	0.20	.000	[1.31, 2.11]
Career Expectations at Age 30	4.77	1.30	.000	[2.80, 8.13]
High School STEM Credit Completion	1.09	0.05	.049	[1.00, 1.20]

completed in high school also marginally predicted the likelihood of postsecondary enrollment in STEM ($\text{Exp}(B) = 1.09, p = .049$). For every unit increase in high school STEM credits completed, BIPOC students had approximately 1.09 times greater odds of majoring in STEM. In other words, BIPOC students who completed more STEM credits in high school were more likely to choose a STEM major in college. Expectation of a STEM career at age 30 was significantly predictive of the likelihood of postsecondary enrollment in STEM majors ($\text{Exp}(B) = 4.77, p < .001$). BIPOC students who see themselves in STEM occupations at age 30 had 4.77 times the odds of enrolling in STEM majors in postsecondary education than those who do not see themselves in STEM occupations at age 30. The only non-statistically significant relationship found was between math identity and postsecondary enrollment in STEM majors ($\text{Exp}(B) = 1.24, p = .252$).

Ad Hoc Analysis

Our team also conducted an auxiliary moderated logistic regression to determine whether gender moderated the relationship between science identity and whether a student majored in STEM in college. These results show that gender, in fact, moderates the relationship between science identity and the likelihood of a collegiate major in STEM, $\text{Exp}(B) = 1.45, p < .001$. For male students, the relationship between STEM identity and the odds of the student majoring in STEM is statistically nonsignificant. For female students, the relationship between STEM identity and odds of the student majoring in STEM is statistically significant, with female students who scored higher on science identity having odds 1.45 times greater for majoring in STEM than female students who scored lower on science identity.

DISCUSSION AND SIGNIFICANCE

Our research seeks to examine variables that influence STEM pathways for BIPOC students. Using the HSL5:09 (NCES, 2009), we examined whether gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion can predict whether a student majors in STEM as an undergraduate. The demographics of our sample of 5,702 participants who identified as American Indian or Alaska Native, Asian, Black or African American, Hispanic, and Native Hawaiian or Other Pacific Islander provided valuable insights into student representation, perceptions, and involvement in STEM throughout high school and college. In this section, we summarize factors influencing students' selection of STEM postsecondary majors within the context of our variables; in addition, we discuss supportive factors toward helping BIPOC students author identity, explore, and participate in STEM fields.

From the logistic regression results, it is shown that gender, science identity, career expectations at age 30, and high school STEM credit completion were all related to BIPOC students enrolling in postsecondary STEM majors. Joining a few emerging studies that identify multileveled factors to foster the persistence of BIPOC students and professionals in STEM fields (see Chemers et al., 2011; Estrada et al., 2018; Merolla & Serpe, 2013), we suggest that the development of STEM identity and career expectation early on for BIPOC students can have an important impact on their college persistence and at the same time be a protective factor when they experience negative stereotypes throughout and beyond college. Our findings contribute to bridging

identified gaps in the literature, including the use of large-scaled analyses that follow a student cohort from high school through college (see Hurtado et al., 2010) and that examine longitudinal influences that STEM identity, participation, and expectation cultivated during high school have on college endeavors, including students' decision to major in STEM (Merolla & Serpe, 2013).

Our study emphasizes the importance of early exposure to STEM classes, practices, and career trajectories to disrupt the lack of STEM participation among BIPOC students. We repeat the needs for educators and advocates to address the disparities of access and meaningful learning experiences in STEM, including providing BIPOC students with opportunities and scaffolding that lead to fulfilling STEM credits and building identity in STEM. Our finding also incites more socially situated and integrative learning designs that attend to students who are historically marginalized in this field. Helping students to see themselves in STEM should be an ongoing intentional goal of career counselors, educators, and other professionals who want to increase success and college-going activities for their underrepresented students. Through coursework and extracurricular activities, STEM engagement that facilitates dynamic, meaningful, and accessible experiences can help minority students imagine and see themselves in STEM (Martin-Hansen, 2018; Polman, 2012; Taylor, 2019) in different ways. Furthermore, both formal and informal learning designs aiming to promote STEM identification—including after-school programs, math and science summer camps, and tutoring programs—should go beyond merely focusing on STEM-related knowledge and skills to addressing embedded sociohistorical implications in the learning and development

of minoritized students in STEM (Bang & Medin, 2010; Langer-Osuna & Nasir, 2016; McGee, 2021; Vossoughi & Vakil, 2018).

LIMITATIONS AND FURTHER RESEARCH

While weekly discussion involving all team members throughout all processes of the research during a period of six months was beneficial in improving the quality and integrity of our study, our analysis encountered limitations. First, our study suffered a lack of diverse representation within our BIPOC students. Hispanic and Black or African American students make up the majority of the sample (45.5% and 28.3%, respectively) and this means that interpretations and conclusions drawn from this study will largely discuss these groups' experiences. Second, the limitation of the HSLS:09 (NCES, 2009) data set in providing response options that reflect the spectrum of gender identity (Christopher, 2021) constrained our ability to report patterns for students whose gender identity differs from their biological or birth sex. Additionally, our analysis has yet to examine other identity dimensions, including geographical differences, income, age, (dis)ability status, immigration status, linguistic backgrounds, and those dimensions' intersectional influences on BIPOC students' engagement with STEM disciplines. Furthermore, it was our original interest to match students' high school data with corresponding college data, including enrollment, persistence, performance (e.g., GPA, credit hours, and engagement in STEM clubs and organizations), and retention (e.g., career trajectory). Due to the researchers' decision to focus on a smaller number of factors already studied in the literature

individually but not collectively, this larger goal remains an area of future opportunities. Recognizing how STEM identities are highly fluid and context specific, we encourage researchers to further investigate other dimensions of identity, beyond race and gender, as well as their longitudinal impacts on BIPOC STEM students.

While the current model is overall statistically significant, the relatively low variance explained by the variables included in the model ($R^2 = .20$) indicates there are additional factors that should be considered when examining why BIPOC students may or may not major in STEM fields. Specifically, the low variance in the logistic regression result is indicative of there being additional factors that have stronger influences on students' choices. Concomitantly, while our descriptive analysis shows that BIPOC students took at least one STEM course in high school, future research is recommended to examine the level of academic involvement in STEM that translates to BIPOC students identifying with math and science or seeing themselves in STEM careers at age 30. A future study might separate high school STEM credits into math credits and science credits earned during high school. This will help to determine whether the number of credits taken in a specific STEM field is more important in determining college major selection than "STEM credits" broadly. In this vein, a more thorough conceptualization of math identity and science identity (e.g., conceptualizations that take into account varying, intersectional experiences among BIPOC students) may provide a more nuanced understanding of the relationship between student math identity and student science identity, as well as postsecondary enrollment in STEM disciplines.

Our study found BIPOC women were less likely to enroll in STEM majors compared to BIPOC men. This

finding is consistent with the literature describing the underrepresentation of BIPOC women in STEM fields and emphasizing their feelings of isolation and exclusion in STEM environments (D. Johnson, 2011; Ong et al., 2018). Prior studies show that gender moderates the relationship between STEM identity and both persistence and academic achievement in STEM (Le et al., 2014; Seyranian et al., 2018). Our findings contribute to the literature by confirming that gender moderated the relationship between science identity and whether a student majored in STEM. Given prior research showing differences in the relationships between self-efficacy, persistence, ability, and STEM outcomes based on gender, future analyses could include gender as a moderator when considering factors influencing STEM-based outcomes among minority students. Without including gender as a moderator, we may misinterpret important findings by considering outcomes as consistent across genders when in fact this may not be the case, as seen in our auxiliary analysis.

CONCLUSION

In closing, our study addresses the shortage of quantitative research illuminating the impact of K-12 experience on BIPOC students in STEM disciplines. Our findings suggest a correlation between gender, science identity, career expectations at age 30, and high school STEM credit completion with postsecondary major (STEM or non-STEM). We recommend integrative ways to support BIPOC students during high school because this critical time shows the potential to impact postsecondary STEM-related outcomes. Furthermore, this research is relevant to STEM educators, career counselors, and other professionals as they explore meaningful ways to create pathways that take into

account STEM-identity development and learning environments that make STEM accessible and meaningful to underrepresented students. Our study encourages researchers and practitioners to investigate opportunities to improve STEM

participation collegiately and career-wise for BIPOC students. In doing so, we highlight our deliberate decision for using critical quantitative approaches—prioritizing socially responsible and ethical research practice—in analyzing large-scale data sets.

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