

Shifting Sands: An Analysis of College Access Deserts from 2001 to 2019

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Abstract

Recent higher education scholarship has recognized the continuing importance of place in college opportunities for students. One of these frames that has been growing in prominence are college access deserts - areas of the country without two public two-year colleges or a public four-year college that accepts at least 75% of applicants. This paper constructs an open access dataset of college access deserts for 2001 to 2019 and argues that education scholars, especially those using this construct, need to carefully consider and state collegiate classifications and the time period of analysis. Using this dataset and data from the American Community Survey, I find that racialized patterns of college access exist when examining 2010 to 2019 that are obscured in single year analysis, particularly for regions with higher than average populations of Black or American Indian/Alaskan Native residents. Scholars of higher education can use this open access dataset of college access deserts to further understand racialized patterns while using principles of open science.

Shifting Sands: An Analysis of College Access Deserts from 2001 to 2019

Geography plays a central role in the lives and opportunities of people living in the United States. Housing laws and practices codified racial segregation by redlining neighborhoods, denying opportunities for people of Color (Rothstein, 2017). Large swaths of the country have limited access to fresh foods in food deserts, affecting both rural and urban areas (Pardilla et al., 2014; Schafft et al., 2009; Smith & Morton, 2009). Since 1970, income inequality between neighborhoods has increased (Mijs & Roe, 2021). Therefore, space has and continues to play an important role in people's lives.

A growing body of scholarship has examined the role of location on one's educational opportunities. This geography of opportunity is uneven and often racialized in the United States (Galster & Killen, 1995; Tate, 2008). Funding for public schools is a clear instance where geography plays an important role in one's opportunity as districts with higher median property values often have higher levels of per pupil funding and higher proportions of white students (Backer, 2020; Caldwell et al., 2022). Another way geography is racialized in education is the recent formation of new, whiter, and wealthier school districts established by succeeding from existing districts (Government Accountability Office [GAO], 2022; Siegel-Hawley et al., 2018; K. Taylor et al., 2019). This practice has functionally reestablished a segregated school system, as today's K-12 public school students are more diverse than in previous generations but more than one third of students attend schools where students of a single race/ethnicity make up over 75% of the student body (GAO, 2022).

One domain of education research that scholars have considered the role of geography is college access. Researchers have found that rural students are less likely to attend highly selective colleges, have less rigorous academic opportunities, and have less robust school and

community support systems (Byun et al., 2017; Means et al., 2016; Sowl & Crain, 2021).

Colleges also make more out of state visits to recruit students in urban areas that are wealthier and whiter (Salazar et al., 2021; Salazar, 2022). These findings consistently reflect that higher education opportunities are influenced by place.

To study the place of colleges and their distribution across the United States scholars have proposed the construct of a college access desert. Akin to food deserts, these regions of the country are areas where students have fewer local opportunities to attend institutions of higher education. This consideration of proximity is important as one's probability of applying to college increases as the number of nearby colleges increases (Turley, 2009). This analytical tool of college access deserts has been applied at both a micro and macro level. For example, at the micro level, Dache-Gerbino (2018) analyzed the geographic distribution of colleges in Rochester, New York. They find that the urban core has a limited number of colleges, but a high concentration of need and People of Color, while the areas outside the urban core have more educational opportunities.

One approach to examine college access deserts at the macro-level uses groups of neighboring counties that reflect transit patterns, called commuting zones, to identify regions of the country that have limited access to highly accessible colleges and universities (Hillman, 2016; Hillman & Weichman, 2016; Klasik et al., 2018; Lee & Pirog, 2023). College access deserts, defined by Hillman and Weichman (2016) and Klasik et al. (2018), are commuting zones that do not have two public two-year colleges or one public four-year college that accepts at least 75% of its applicants. This research on college access deserts have shown that 20% of Indigenous people live in a college access desert (Hillman & Weichman, 2016). Students in college access deserts are less likely to be Black, Hispanic, or Asian, but more likely to be higher

income and first generation college students (Klasik et al., 2018). Educational opportunities within a commuting zone also impact student choice, as the presence of for-profit colleges in a commuting zone increases the probability students attend a for-profit instead of a community college (Lee & Pirog, 2023).

As this macro-level conception of college access deserts using commuting zones gains wider use in the field of higher education it is important to carefully examine this construct's definition. Klasik and colleagues (2018) note that their findings diverge from Hillman and Weichman (2016) about the demographic composition of college access deserts, potentially because of a temporal element or examining college-aspiring students compared to the entire zone's demographics. Classifications of commuting zones have been updated once per decade since their initial conceptualization in 1987 by Tolbert and Killian (Fowler et al., 2016). Admissions rates for public four-year colleges also vary over time, so a negligible change in admissions rate from 74.5% to 75.5% could re-classify a commuting zone from a college access desert to an oasis. This change should not meaningfully impact a student's college going decisions but without attention to the temporal nature of these classifications researchers could be led astray. Both of these concerns give credence to a potential temporal difference in college access desert classifications.

A second concern with literature in college access deserts is the classification of two-year colleges. Romano and D'Amico (2021) noted that classifications from the Integrated Postsecondary Education Data System (IPEDS) of two-year colleges undercounts community colleges because an institution that offers a four-year degree is classified as a four-year college. Hillman (2016) uses classifications of sector (public/private two/four year degree-granting colleges), while Klasik et al. (2018) and Lee and Pirog (2022) do not explicitly name how the

classification used to determine two-year colleges. Given Romano and D’Amico’s (2021) recent concerns about IPEDS classifications of community colleges and that determining if a commuting zone is a college access desert requires a count of two-year colleges this operationalization of “two-year college” needs to be explicitly stated by scholars.

Given these temporal and classification concerns, further utilization of college access desert classification should be based on a shared commitment to transparency. These choices matter and can influence findings and policy. At minimum, scholars should carefully describe how they determine if a commuting zone is a college access desert in ways that describe the time period and how they determine if an institution is a community college. However, this may still fail to fully address ongoing concerns about replicability in the social sciences. Therefore, the optimal solution is to advance open science through open data practices like publishing code or datasets for analysis (van der Zee & Reich, 2018). This path forward for the conceptualization of college access deserts that is grounded in open science principles can increase the use of these college access deserts in scholarly and policy spheres (Furlough, 2010; Gershenson et al., 2020).

This paper’s primary purpose is to develop and disseminate a publicly available database of college access deserts in the United States to address these concerns with the current operationalization of college access deserts in higher education literature. I also examine if these choices matter in the analysis of the geography of educational opportunity.

I first construct a database of college access deserts from 2001 to 2019 using two different collegiate classifications - sectors of higher education from IPEDS and Carnegie Classifications from the Carnegie Foundation for the Advancement of Teaching. I find that using IPEDS sectors lead to more counties across the United States classified as college access deserts in 14 of 19 years. I next consider the utility of this database and the differences between

classifications by using five-year demographic and economic estimates from the American Community Survey (2015-19; U.S. Census Bureau, 2020a) to determine which characteristics of commuting zones are associated classification as a college access desert. I conduct this analysis for both IPEDS and Carnegie classifications in 2019 and for the decade beginning in 2010. While logistic regressions for both college access desert classifications yield similar results, the different collegiate classifications do have divergent findings especially in the longitudinal measure of college access deserts that may influence researcher's interpretation of their results. For example, a commuting zone with a percentage of American Indian or Alaskan Native residents one standard deviation above the mean has 1.39 times greater odds ($p = 0.013$) of being classified as a college access desert from 2010 to 2019 when classifying colleges using IPEDS sectors, but this value is not statistically significant when using Carnegie Classifications (1.24 times greater odds, $p = 0.099$). This difference may not be substantial but may lead to different interpretations by researchers or policymakers about opportunities to attend nearby, accessible institutions of higher education. I conclude by recommending careful consideration of college classifications in college access research.

Method

I begin by describing the construction of college access deserts from 2001 to 2019 using R (R Core Team, 2022), a free statistical software. Then, I describe methods in a study to compare how these operationalizations may impact one's findings.

Constructing College Access Deserts

I define college access deserts as commuting zones that do not have one public four-year undergraduate degree-granting college that accepts at least 75% of applicants or two public two-year undergraduate degree-granting colleges, largely aligning with prior definitions (Hillman &

Weichman, 2016; Klasik et al., 2018). Commuting zones that are not college access deserts are college access oases. One key area of potential divergence is that I explicitly only include degree granting institutions when making classification decisions, which may decrease the number of two-year colleges by eliminating trade schools. This narrows the interpretation of college access deserts to commuting zones where students do not have highly accessible and nearby opportunities to earn degrees. This choice emphasizes that not all higher education opportunities are equal and prioritize degrees as an educational outcome.

I accessed publicly available data from IPEDS using the R package `educationdata` (Ueyama, 2022) for public colleges and universities between 2001 to 2019. This time period was selected because colleges began reporting the number of applicants and the number of accepted students to IPEDS in 2001 and 2019 is the most recent year in which commuting zone data was available. This provided a dataset of 2,570 unique public institutions for a total of 40,938 public colleges for the 19 years in the analysis.

Prior to 2009, colleges did not report their county when completing IPEDS surveys. As a college's county¹ is required to place it into a commuting zone, it was necessary to copy the FIPS codes from later years of IPEDS data to include the 17,843 cases from the eight years prior to 2009. I began by copying county FIPS codes from 2009 reporting years for these missing cases, matching on IPEDS UnitID, because 2009 is the closest time period available to these missing cases. After merging county FIPS codes from 2009, 16,865 institutions from 2001 to 2008 had county FIPS codes, leaving 978 cases with missing FIPS codes. I then merged later FIPS codes for each subsequent year between 2010 and 2019, adding an additional 103 institutions to the dataset. After this process, 875 institutions across all years were excluded

¹ Counties include county-equivalent units in Louisiana (parishes) and Alaska (boroughs).

because their FIPS codes remained missing.

College Access Deserts by Sector

From this dataset of public colleges, I next constructed a measure of a college access desert/oasis using IPEDS classifications of colleges by sector. After selecting four-year public institutions (a value of 1 for the Sector Variable in IPEDS Institutional Characteristics Survey [Urban Institute, 2022]) that offered undergraduate degrees, I then calculated the admission rate for each institution by dividing the number of admitted students by the number that applied. I then selected institutions with an admission rate greater than or equal to 75%, leaving 4,282 institutions across 19 years that met the inclusion criteria. Finally, the colleges were counted by county for each year.

To select two-year colleges, I selected public two-year institutions (a value of 4 for the Sector variable in the IPEDS Institutional Characteristics survey [Urban Institute, 2022]) that offer undergraduate degrees. I then counted these institutions by county for each reporting year.

After selecting these colleges and the number of highly accessible colleges in a county for the 19 years under consideration, I grouped colleges by commuting zone. These zones are groups of neighboring counties and were originally constructed by the United States Department of Agriculture's Economic Research Service (ERS) for 1980, 1990 and 2000 (Economic Research Service, 2019). The ERS did not report commuting zones in 2010 so Fowler, Rubart, and Jensen (2016) delineated commuting zones for 2010. As noted by Fowler and colleagues (2016) and Fowler and Jensen (2020), using the methodology used by ERS in prior delineations produced some discrepancies (potentially because of changes to survey methodology) so they recommend using a modified delineation for 2010, especially for longitudinal analysis. Therefore, for the years 2001 to 2009 I use ERS delineations of commuting zones and for 2010

to 2019 I use the modified delineations constructed by Fowler and colleagues (2016).

Finally, using these counts of highly accessible public colleges by commuting zone for each year, I determined if each commuting zone is a college access desert or oasis based on the above definition. I then constructed various longitudinal measures including the total number of years a commuting zone was a college access desert, if a commuting zone was ever a college access desert, or if a commuting zone was consistently a college access desert for three periods (2001-2009, 2010-2019, 2001-2019). The frequency of college access deserts for each of these measures is provided in Table 1. I finally merged these results with geographic data from the Census using the R package *tigris* (Walker, 2016, 2023). I used these geographic boundaries to construct maps for 2001, 2019, and commuting zones that were always in college access deserts from 2010-2019, as shown in Figures 1, 2, and 3.

College Access Deserts by Carnegie Classification

I next delineated college access deserts using Carnegie Classifications to address Romano and D’Amico’s (2021) concern that IPEDS classifications undercount community colleges. Using data archived on the Carnegie Classification website (Carnegie Foundation for the Advancement of Teaching, 2010, 2018, 2019a, 2019b, 2021), I added Carnegie Classifications for each instructional year to IPEDS data. The typology of Carnegie Classifications has shifted over the past two decades. Table 2 includes the Basic Carnegie Classifications used to delineate four-year and two-year colleges from the dataset of public colleges constructed above. Tribal colleges and universities consistently receive their own Carnegie Classification and as these institutions tend to predominately offer associate degrees they are classified as two-year colleges in this analysis. Special focus institutions were excluded, as they provide a narrow set of educational opportunities that are focused on a specific career path like health, technical, or arts

and design professions. Examples include the Franciscan School of Theology, Le Cordon Bleu College of Culinary Arts, and Pima Medical Institute.

Similar to constructing college access deserts/oases by IPEDS sector, I began by selecting two- and four-year colleges from the Carnegie Classifications listed in Table 2 that offered undergraduate degrees. I then selected four-year colleges with admissions rates of at least 75%. As before, I counted the remaining institutions by ERS commuting zone for 2001 to 2009 and Fowler and colleagues' (2016) modified commuting zones for 2010 to 2019.

Using these counts, I determined if each commuting zone from 2001 to 2019 met the criteria for classification as a college access desert (no four-year highly accessible degree-granting public college or less than two public degree-granting two-year colleges). As before, I made these determinations by year and constructed the same longitudinal measures. Table 1 includes the number of college access deserts by Carnegie Classification for each year in the database. See Figures 1, 2, and 3 for maps of commuting zones by Carnegie Classification for 2001, 2019, and commuting zones that were always college access deserts from 2010 to 2019.

Characteristics of Commuting Zones

To show the utility of the college access desert database and how college classifications vary one's findings I conducted two sets of analyses using the American Community Survey (ACS) five-year estimates from 2015 to 2019.

Using the `tidycensus` package for R (Walker & Herman, 2022), I collected ACS data for each county. These include gender and racial demographics, the number of children in poverty, the number of individuals with a bachelor's degree or higher, number of residents with broadband, and the number of unemployed residents in the labor force. These characteristics align with similar research on education deserts (e.g., Hillman, 2016; Hillman & Weichman,

2016). I then aggregated these estimates by commuting zone. To consider rurality, I measured the population density of each commuting zone, measured by people per square mile. Finally, I determined the percentage of residents in each commuting zone for each characteristic of interest. See Table 3 for the means and standard deviations of these values by commuting zone.

The outcome for each analysis was if a commuting zone is classified as a college access desert. As this outcome is binary, I used logistic regression (Keith, 2015) to determine what demographic characteristics are associated with college access deserts. I first considered if a commuting zone was in a college access desert in 2019, followed by if a commuting zone was always a college access desert between 2010 and 2019. In this analysis, the percentage of white residents is the reference category for racial demographics as this group had the highest mean value. To facilitate interpretation, the variables were z-standardized in each regression analysis.

Findings

The findings first describe how college access deserts vary when using IPEDS sectors and Carnegie Classifications. I then describe the commuting zone characteristics associated with classification as a college access desert.

Comparison of College Classifications

The first purpose of this paper is to determine college access deserts for the United States between 2001 and 2019 using publicly available data using two different collegiate classifications. As shown in Table 1, the number of counties identified in college access deserts varies between classifications and over time.

First, IPEDS sector classifications of colleges have more counties identified as college access deserts than using Carnegie Classifications. The years that the Carnegie Classifications have higher numbers of college access deserts are mostly those that use the 2000 Carnegie

Classification (four out of five years). This change then is likely because of a change in Carnegie Classifications that began in 2005 that provided more detail on an institution's control and degree offerings. The consistent results in Table 1 between classification systems also aligns with Romano and D'Amico's (2021) claim that IPEDS undercounts the number of community colleges and increases the number of institutions classified as four-year colleges. As a commuting zone with two public two-year colleges is not classified as a college access desert, an increase in the number of four-year colleges (as IPEDS sectors would create) would potentially increase the commuting zones classified as a college access desert if their published admissions rates do not meet the 75% benchmark.

Second, a temporal pattern also appears in the number of college access deserts. The highest number of counties were classified as college access deserts in 2009 (1,456 via IPEDS sector and 1,426 via Carnegie Classifications). This period coincides with the Great Recession – when unemployment rates were high and there was an increase in the number of college applications in the United States (Bell & Blanchflower, 2011). This increased interest in attending college may have decreased admittance rates at four-year colleges, potentially shifting some commuting zones into college access deserts.

Another pattern also emerges longitudinally - as generally since 2001 fewer counties are identified as college access deserts. This indicates that as time has passed larger portions of the United States have seen increased access to higher education. This appears most dramatic when using Carnegie Classifications - but that may be driven by changes in the classification system. The data in Table 1 shows the land area (counties) that were college access deserts. This count of counties does not reflect the percentage of the population living in college access deserts at a state or national level.

This paper also mapped the college access deserts for three periods - 2001, 2019 and the decade from 2010 to 2019 as shown in Figures 1, 2, and 3. These maps show the geographic distribution of college access deserts. They show that college access deserts consistently dominate the middle of the continental United States. For example, most of eastern Idaho, Wyoming, and western Nebraska are consistently identified as college access deserts across time with both IPEDS sector and Carnegie Classifications. Regions like these that are consistently identified as a college access desert across time and college classifications may be sites worthy of policy intervention at multiple levels to increase college access and to achieve postsecondary educational goals.

Using the College Access Deserts Database

The code used to construct this dataset is available at: <https://osf.io/bzp4k> (Winfield, 2023). This repository also contains the code used to construct maps and conduct the analysis discussed above.

Researchers using these classifications should note a few important limitations. First, for longitudinal analysis commuting zones and county boundaries have shifted over this period. This is especially relevant in Alaska where the boroughs (the county-level unit) do not cover the entire state and have shifted over time. Therefore, researchers interested in longitudinal analysis that spans multiple Census years should ensure that boundaries remain consistent in the location of their analysis.

Another emerging concern with the current database is that commuting zones have not been provided by the ERS since 2000 (ERS, 2019). For research spanning into the 2020s and beyond this is an important consideration as an authoritative, common classification will potentially increase the uptake and improve the replicability of research on college access

deserts. The Office of Management and Budget has announced that it is constructing a new delineation of the entire United States for publication later this decade (2020 Standards for Delineating Core Based Statistical Areas, 2021). Given the temporal nature of commuting zones and college access deserts, scholars of higher education interested in these geographic constructions should note this potential forthcoming delineation for research about college opportunities in 2020 and beyond.

Characteristics of College Access Deserts

The second phase of this study examined characteristics of commuting zones associated with designation as a college access desert in 2019 and from 2010 to 2019. Using logistic regression, I conducted each analysis with the same independent variables and varied the outcome to consider the implications of different collegiate classifications.

College Access Deserts in 2019

I first examined what commuting zone characteristics were associated with designation as a commuting zone for the year 2019, as shown in Table 4 and mapped in Figure 2. The different collegiate classifications lead to largely similar results in directionality and magnitude. In particular, none of the racial/ethnic categorizations were statistically significant predictors of a commuting zone being classified as a college access desert in 2019.

Of the variables that were statistically significant, they were often in the expected direction. For example, commuting zones with higher-than-average percentages of male residents had 1.68 and 1.35 times greater odds of being classified as a college access desert using the IPEDS Sector and Carnegie Classifications respectively, as fewer men in the United States had attained an associate's degree or higher in 2019 (U.S. Census Bureau, 2020b). Commuting zones with higher than average percentages of residents with a bachelor's degree or higher were

less likely to be classified as a college access desert, aligning with prior research that most students enroll in colleges near their high schools or community (Hillman & Weichman, 2016; Hirschl & Smith, 2020; Turley, 2009) and colleges employ large numbers of people with degrees – a key component of the ‘college town’ archetype (Gumprecht, 2008). Of note is that commuting zones with higher-than-average unemployment rates had lower odds of being classified as a college access desert than commuting zone with average unemployment rates (0.63 times odds using sector classifications and 0.68 times odds using Carnegie Classifications).

One area where the magnitude of coefficients varied by classification was the association between population density. For commuting zones with a one standard deviation population density above the mean the commuting zone had 0.79 times the odds when using IPEDS sector classification and was not statistically significant. When using Carnegie Classifications however, a commuting zone with a one standard deviation population density above the mean had 0.14 times the odds of being a college access desert and this estimate is statistically significant ($p < 0.001$). This meaningful difference in both magnitude and significance further advances the idea that how one classifies colleges as two- and four-year institutions may meaningfully impact one’s findings.

College Access Deserts: 2010 to 2019

The second regression analysis examined the characteristics associated with a commuting zone being classified as a college access desert for the entire 10-year period from 2010 to 2019. As shown in Table 5 these results are similar in directionality for both collegiate classifications but vary for some characteristics in magnitude and statistical significance. These college access deserts are mapped in Figure 3.

As with the college access deserts in 2019, population density was statistically

significant. When classifying colleges by IPEDS sector, a commuting zone with a population density one standard deviation above the mean had 0.34 times the odds of being classified as a college access desert compared to a commuting zone with a population density at the mean. Again, mirroring the earlier analysis, this is much larger when using Carnegie Classifications. The results are also similar for the percentage of residents with a bachelor's degree or higher and percentage of unemployed residents between the two time periods under consideration.

The results for this longitudinal approach however do vary in meaningful ways, especially regarding race and ethnicity as none of the racial or ethnic categories were statistically significant predictors of classification as a college access desert in 2019. The percentage of Black residents in a commuting zone is negatively associated with classification as a persistent college access desert from 2010 to 2019, such that a commuting zone with a percentage of Black residents one standard deviation above the mean had 0.75 times lower odds ($p = 0.040$) compared to a commuting zone with an average percentage of Black residents when using IPEDS sector classifications (0.72 times lower odds when using Carnegie Classifications, $p = 0.019$). When using IPEDS Sector classifications the percentage of American Indian and Alaskan Native residents was positively associated with classification as a persistent college access desert from 2010 to 2019. A commuting zone with a percentage of Indigenous residents one standard deviation above the mean had 1.39 times greater odds of classification as a college access desert ($p = 0.013$) compared to a commuting zone with an average percentage of Indigenous residents when using IPEDS Sectors. This variable was not statistically significant when using Carnegie Classifications ($p = 0.993$).

Discussion

Recent educational research has prioritized the importance of place and geography -

especially in regard to college access (Salazar et al., 2021; Salazar, 2022; Sowl & Crain, 2021; Turley, 2009). Scholars have consistently found that the spatial distribution of colleges is an important area to understand college opportunities in the United States, especially given the country's racialized geography (Dache-Gerbino, 2018; Hillman, 2016; Hillman & Weichman, 2016; Klasik et al., 2018; Lee & Pirog, 2023). This paper produced a public database of regions of the country (Winfield, 2023) that have limited access to highly accessible public colleges and universities - what Hillman and Weichman (2016) termed college access deserts. In doing so, it highlights the importance of clarity in higher education research for replicability and how seemingly innocuous choices can lead to different results and policy recommendations.

First, I investigated how time and collegiate classifications may change how commuting zones are classified as college access deserts. As shown in Table 1, there are temporal patterns - the greatest number of counties were identified as college access deserts during the Great Recession (2008-09). This may have been driven by increased demand (i.e., the number of applicants) during this economic downturn. Similarly, using IPEDS Sectors instead of Carnegie Classifications to identify two- and four- year colleges was associated with greater numbers of counties identified as college access deserts in 14 of 19 years. This finding gives further credence to Romano and D'Amico's (2021) claim that classification systems of two-year colleges should be carefully considered when conducting research.

These patterns indicate support for two important considerations when conducting geo-temporal research in higher education, including the work on college access deserts. At minimum, scholars should provide these details in their analysis. For example, scholars should consider and then make explicit about the time period(s) and how they classify institutions as two- or four-year colleges. Researchers can also build on open-science principles by (1) using

the database of college access deserts provided here, (2) publishing their own county-level classifications, or (3) publishing the code used to construct college access deserts. Moving towards open science principles can increase the uptake of the idea of college access deserts in policy and practice (Furlough, 2010; Gershenson et al., 2020). These guidelines can also be implemented for other constructs to increase the potential use across the field.

Second, using logistic regression, I analyzed what characteristics of commuting zones are associated with a commuting zone classified as a college access desert in 2019 and the period from 2010 to 2019. These temporal differences in outcomes also highlighted meaningful differences in findings. This aligns with prior differences in college access desert classifications from Hillman (2016) and Klasik and colleagues (2018). This finding further supports the claim that temporal access and the sampling population can lead to divergent findings about the college access desert construct (Klasik et al., 2018). When considering 2019 exclusively, I do not find that racial/ethnic characteristics of a commuting zone are statistically significant predictors of classification as a college access desert.

However, when examining the 2010s as an entire decade, I find that higher percentages of Black residents in a commuting zone is associated with increased likelihood of not being a college access desert in longitudinal analysis, similar to Hillman's (2016) finding that Black commuting zones tend to have higher numbers of nearby colleges. Yet, Black people have lower bachelor's attainment rates than the national average (National Center for Education Statistics [NCES], 2021). Critical quantitative scholars call on scholars to recognize the centrality of racism and to think about racism in how one interprets their results (Gillborn et al., 2018; Castillo & Gillborn, 2022). In this instance, why are areas with higher concentrations of Black residents more likely to have access to widely accessible public colleges and yet have lower

bachelor's educational attainment rates? Given the long-standing exclusion of Black people from higher education and defunding of colleges with missions to serve Black communities (Dancy et al., 2018; A. Harris, 2021), this difference is driven by recent and long-standing racist policy and choices that continue to ripple through American higher education today. This discrepancy at the macro-level highlights the importance of smaller scale analyses, like Dache-Gerbino's (2018) analysis of Rochester, New York, to fully understand racialized access to higher education in urban places. Further research should follow Dache-Gerbino's (2018) work and examine opportunities at a local level, while also seeking to understand the tension between increased local access to highly accessible public colleges and lower attainment rates for Black people.

Another key finding is that commuting zones with higher-than-average populations of American Indian and Alaskan Native people were more likely to be classified as college access deserts for the entirety of 2010-2019, echoing prior research (Hillman & Weichman, 2016). As of the 2010 Census, 78% of American Indian/Alaskan Natives lived outside of tribal statistical areas, including reservations (Office of Minority Health, 2022), potentially indicating that all areas with high percentages of American Indian and Alaskan Native people, not just residents of tribal statistical areas, have decreased access to highly accessible colleges. Similar to Black people, American Indian and Alaskan Native people have attained bachelor's or graduate degrees at lower rates than the national average (15.9% compared to 33.2% in 2019; NCES, 2021). Therefore, state and federal policies should support expanded access to public higher education in regions with above average percentages of American Indian and Alaskan Natives, as these regions persistently have fewer opportunities to attend nearby, highly accessible public colleges.

Research on the geographic distribution of colleges through concepts like college access

deserts provides an important way to understand the role of space and place in the college-going process. Working towards open science in education and implementing critical interpretations of findings are necessary to understand build a shared understanding of how the geography of educational opportunity remains unequal and together build a more equitable higher education system.

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Table 1 *Counties Classified As College Access Deserts: 2001-2019*

Year	Classification using IPEDS Sector	Classification using Carnegie Classification
2001	1,343	1,415
2002	1,338	1,396
2003	1,324	1,389
2004	1,361	1,396
2005	1,364	1,341
2006	1,374	1,369
2007	1,410	1,385
2008	1,455	1,423
2009	1,456	1,426
2010	1,339	1,296
2011	1,369	1,310
2012	1,400	1,310
2013	1,362	1,276
2014	1,371	1,285
2015	1,348	1,277
2016	1,405	1,324
2017	1,376	1,282
2018	1,331	1,233
2019	1,336	1,219
2001 - 2009 (Any year)	1,660	1,682
2001 - 2009 (Most years)	1,377	1,372
2001 - 2009 (All years)	1,114	1,129
2010 - 2019 (Any year)	1,728	1,594
2010 - 2019 (Most years)	1,378	1,297
2010 - 2019 (All years)	1,047	1,016

Note: There are 3,138 counties in 2001 to 2019 and 3,143 counties in 2010 to 2019.

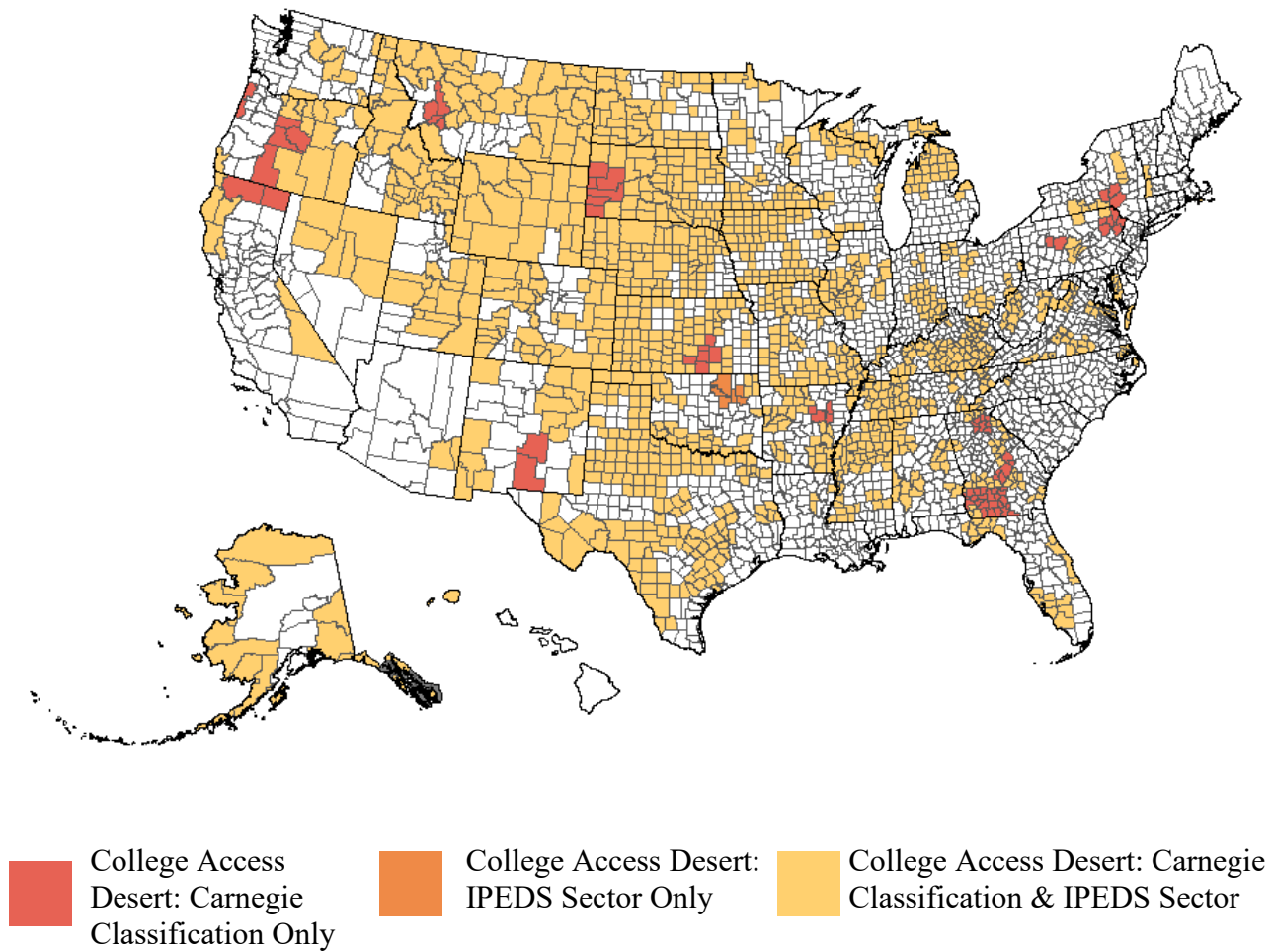
Figure 1. *College Access Deserts: 2001*

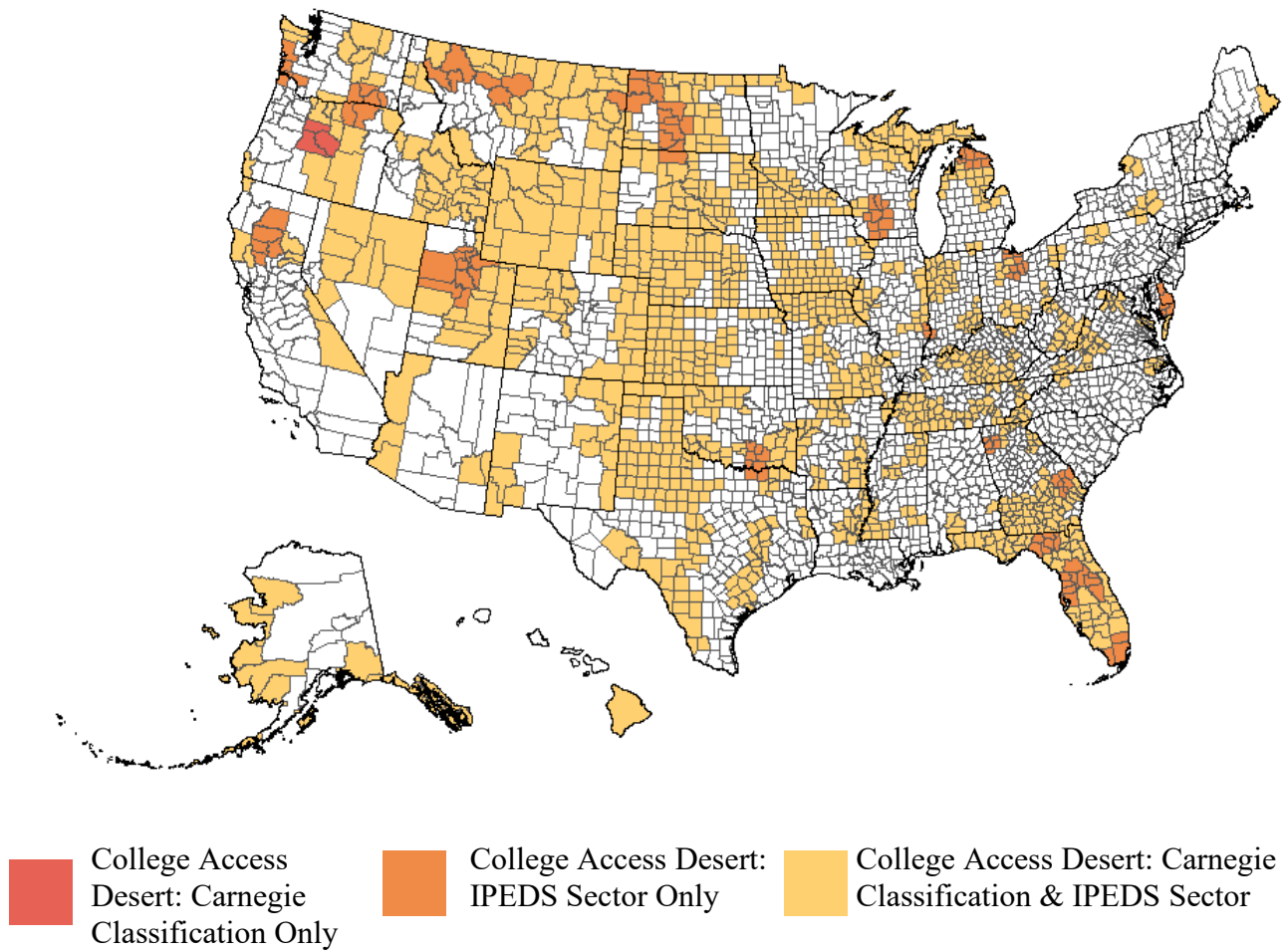
Figure 2. *College Access Deserts: 2019*

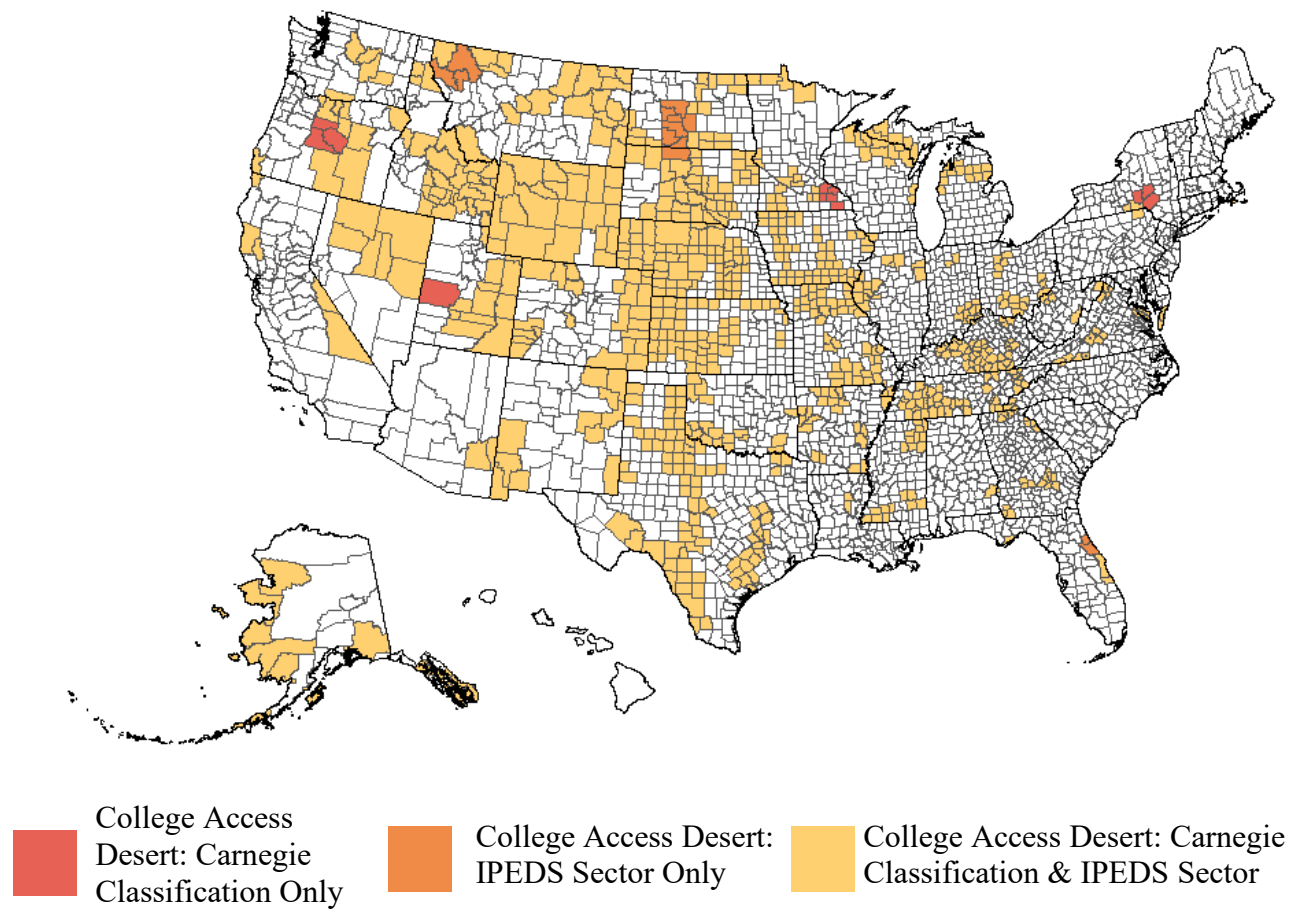
Figure 3. *College Access Deserts: 2010-2019*

Table 2. *Carnegie Classifications For Two- And Four-year Colleges*

Carnegie Classification Year	College Access Desert Years	Basic Carnegie Classifications for four-year colleges	Basic Carnegie Classifications for two-year colleges
2000	2001, 2002, 2003, 2004	Doctoral/Research Universities – Extensive & Intensive Master’s Colleges and Universities I & II Baccalaureate Colleges - Liberal Arts & General Baccalaureate/Associate’s Colleges	Associate’s Colleges Tribal Colleges and Universities
2005	2005, 2006, 2007, 2008, 2009	Research Universities (very high and high research activity) Doctoral/Research Universities Master's Colleges and Universities (larger, medium and smaller programs) Baccalaureate Colleges--Arts & Sciences & Diverse Fields Baccalaureate/Associate's Colleges	Associate's--Public Rural-serving Small, Medium, and Large Associate's--Public Suburban-serving Single Campus and Multicampus Associate's--Public Urban-serving Single Campus and Multicampus Associate's--Public 2-year colleges under 4-year universities Associate's--Public 4-year Primarily Associate's Tribal Colleges
2010	2010, 2011, 2012, 2013, 2014	Research Universities (very high and high research activity) Doctoral/Research Universities Master's Colleges and Universities (larger, medium and smaller programs) Baccalaureate Colleges--Arts & Sciences & Diverse Fields Baccalaureate/Associate's Colleges	Associate's--Public Rural-serving Small, Medium, and Large Associate's--Public Suburban-serving Single Campus and Multicampus Associate's--Public Urban-serving Single Campus and Multicampus Associate's--Public 2-year colleges under 4-year universities Associate's--Public 4-year Primarily Associate's Tribal Colleges
2015	2015, 2016, 2017	Doctoral Universities: Highest, Higher & Moderate Research Activity Master's Colleges & Universities: Larger, Medium & Small Programs Baccalaureate Colleges: Arts & Sciences Focus & Diverse Fields Baccalaureate/Associate's Colleges: Mixed Baccalaureate/Associate's	Associate's Colleges: High Transfer, Mixed Transfer/Career & Technical, High Career & Technical, High traditional, Mixed traditional/nontraditional, High nontraditional Baccalaureate/Associate's Colleges: Associate's Dominant Tribal Colleges
2018	2018, 2019	Doctoral Universities: Very High and High Research Activity Doctoral/Professional Universities Master's Colleges & Universities: Larger, Medium, and Smaller Programs Baccalaureate Colleges: Arts & Sciences Focus & Diverse Fields Baccalaureate/Associate's Colleges: Mixed Baccalaureate/Associate's	Associate's Colleges: High Transfer, Mixed Transfer/Career & Technical, High Career & Technical, High traditional, Mixed traditional/nontraditional, High nontraditional Baccalaureate/Associate's Colleges: Associate's Dominant Tribal Colleges

Table 3.*Descriptive Statistics Of Commuting Zones, American Community Survey 2015-2019*

Variable Name	Mean	Standard Deviation
Population density, people per square mile	121.66	357.26
Percentage of Male residents	50.03	1.58
Percentage of Black residents	8.43	12.05
Percentage of American Indian & Alaskan Native residents	2.96	9.42
Percentage of Asian Residents	1.89	3.46
Percentage of Native Hawaiian/Pacific Islander Residents	0.15	0.66
Percentage of Multiracial residents	0.3	0.29
Percentage of white residents	81.57	15.46
Percentage of Hispanic residents	10.75	13.88
Percentage of children with a ratio of income to poverty below 1	19.9	7.59
Percentage of residents with a Bachelor's degree or higher	24.42	7.96
Percentage of residents with broadband	76.23	7.01
Percentage of unemployed residents	5.26	2.16

Table 4. *College Access Desert Classifications: 2019, Regressed On Commuting Zone Characteristics*

	College Classification: IPEDS Sector Odds Ratio	College Classification: Carnegie Classification Odds Ratio
Population density (people per square mile)	0.79 [0.36-1.29]	0.14*** [0.04-0.42]
Percentage of Male residents	1.68*** [1.26-2.29]	1.35* [1.04-1.80]
Percentage of Black residents	0.90 [0.70-1.16]	0.87 [0.68-1.12]
Percentage of American Indian & Alaskan Native residents	1.31 [1.01-1.75]	1.20 [0.94-1.58]
Percentage of Asian Residents	0.67 [0.45-1.01]	0.88 [0.59-1.38]
Percentage of Native Hawaiian/Pacific Islander Residents	1.24 [0.96-1.69]	1.13 [0.87-1.56]
Percentage of Multiracial residents	1.06 [0.79-1.43]	0.97 [0.74-1.29]
Percentage of Hispanic residents	0.94 [0.73-1.21]	0.95 [0.74-1.22]
Percentage of children with a ratio of income to poverty below 1	0.75 [0.51-1.13]	0.83 [0.56-1.23]
Percentage of residents with a Bachelor's degree or higher	0.38*** [0.27-0.53]	0.44*** [0.31-0.61]
Percentage of residents with broadband	0.81 [0.57-1.15]	0.83 [0.59-1.17]
Percentage of unemployed residents	0.63** [0.46-0.85]	0.68* [0.50-0.92]
Intercept	1.27 [1.03-1.56]	0.84 [0.64-1.08]
Tjur's R-squared	0.282	0.294

Note: R-squared values calculated with the performance package (Lüdtke et al., 2021). All variables are z-standardized for each logistic regression. Ninety-five percent confidence intervals are provided in brackets after the estimate. N= 622 commuting zones.

*p <0.05, **p <0.01, ***p<0.001

Table 5. *College Access Desert Classifications: 2010-19, Regressed On Commuting Zone Characteristics*

	College Classification: IPEDS Sector Odds Ratio	College Classification: Carnegie Classification Odds Ratio
Population density	0.34* [0.11-0.91]	0.04*** [0.01-0.16]
Percentage of Male residents	1.30 [1.01-1.71]	1.14 [0.89-1.48]
Percentage of Black residents	0.75* [0.57-0.98]	0.72* [0.54-0.94]
Percentage of American Indian & Alaskan Native residents	1.39* [1.08-1.83]	1.24 [0.97-1.61]
Percentage of Asian Residents	0.96 [0.65-1.50]	1.11 [0.74-1.87]
Percentage of Native Hawaiian/Pacific Islander Residents	0.73 [0.39-1.15]	0.67 [0.35-1.08]
Percentage of Multiracial residents	0.93 [0.70-1.23]	0.94 [0.72-1.25]
Percentage of Hispanic residents	1.08 [0.85-1.39]	1.00 [0.78-1.29]
Percentage of children with a ratio of income to poverty below 1	0.65* [0.44-0.96]	0.71 [0.48-1.05]
Percentage of residents with a Bachelor's degree or higher	0.37*** [0.26-0.52]	0.40*** [0.28-0.56]
Percentage of residents with broadband	0.74 [0.52-1.04]	0.80 [0.56-1.12]
Percentage of unemployed residents	0.62** [0.46-0.83]	0.68* [0.50-0.91]
Intercept	0.68** [0.52-0.87]	0.43*** [0.30-0.60]
Tjur's R-squared	0.305	0.336

Note: R-squared values calculated with the R package performance (Lüdtke et al., 2021). All variables are z-standardized for each logistic regression. Ninety-five percent confidence intervals are provided in brackets after the estimate. N = 622 commuting zones.

*p < 0.05, **p < 0.01, ***p < 0.001