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Substance use disorders among older populations: What role do race and ethnicity play in treatment and completion?☆

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ABSTRACT

Research that explores the role of substance use treatment among older individuals is scarce. This paper offers a historical investigation of admissions and discharges for treatment episodes over the past two decades across race, ethnicity, gender, and age. Our results suggest that although older individuals are not typically associated with risky behavior, they are increasingly seeking treatment for substance use disorders. We find that substance use treatment admissions for people aged 50 and older have persistently increased over our sample period. Our findings also indicate that, on average, Black (relative to white) admissions across all ages are less likely to complete treatment and more likely to have their treatment terminated by a treatment facility. We also find some evidence that Hispanic admissions are relatively less likely to complete treatment across all age groups. Hispanics over 50 years old are also more likely to terminate treatment. Interestingly, among younger individuals in the most recent years of our sample, the disparity between minority completion rates has improved. Lastly, we find that males (relative to females) are more likely to complete a substance use treatment program but no more likely to have their treatment terminated by a substance use treatment facility.

1. Introduction

Twenty million Americans aged 12 or over had a substance use disorder (SUD) in 2018 (Substance Abuse and Mental Health Services Administration, 2019). There were 70,237 drug overdose deaths in the United States in 2017 (Centers for Disease Control and Prevention (2019)). Substance abuse is currently the number one cause of injury deaths in the United States; preventing such deaths requires an understanding of and ability to treat substance use disorders that we currently lack. Crucially, it also requires addressing SUDs among individuals of all ages, not just younger adults. The lack of information pertaining to substance use among older adults makes this population particularly vulnerable to SUDs and complications arising from substance misuse. In 2018, adults aged 55 to 75 accounted for 22.4% of all overdose deaths, substantially more than the 8.5 percent of overdose deaths among this age group in 1999 (Centers for Disease Control and Prevention, National Center for Health Statistics, 2018).

The first wave of baby boomers turned 65 years old in 2011; coincidentally, 2011 was also the year the United States began combating the opioid epidemic. During this time, the United States faced an upsurge in substance use that claimed an unprecedented number of lives and required substantial state and federal resources. From 1999 until 2017, drug overdoses persistently increased. Overdose deaths in 2017 were 300% of 1999 levels (Centers for Disease Control and Prevention, 2019). Of the lives claimed by opioid overdoses, 40% (18,084) were age 45 or older. Historically, research has treated SUDs as primarily affecting younger adults; however, as baby boomers age, the number of older adults using substances and seeking treatment has grown substantially. In 1992, substance use treatment admissions over 50 years old accounted for 6.5% (102,705) of total admissions across all age groups. In the most recent year of available data, 2017, the same age group accounts for roughly 17% (333,728) of treatment admissions captured in Treatment Episode Data Set – Admissions (TEDS-A) (Substance Abuse and Mental Health Services Administration, 2018).

Access to proper treatment is imperative in treating SUDs and the myriad of comorbidities associated with them. Treatment is especially important for older adults, who are more likely to have multiple chronic health conditions associated with greater prescription medication use and, consequently, greater risk for adverse drug interactions (Lehmann & Fingerhood, 2018). Nonetheless, screening for substance use and

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alcohol disorders is not routinely part of medical visits for older adults. This lack of screening is particularly worrisome given that the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria clearly states that older adults "may be more impaired using the same amount" of a substance taken by a younger individual (American Psychiatric Association, 2013).

Though researchers tend to overlook SUDs among older populations, Han et al. (2009) project that SUDs among individuals 50 years of age or older will rise to about 6 million in 2020. Similarly, other researchers have identified the possible challenges treatment facilities could encounter as America faces a rise in SUDs among older populations (B. H. Han et al., 2017; Rothrauff et al., 2011).

The U.S. Census Bureau (2018) estimates that the total number of adults 65 and older will rise from 40.3 million in 2010 to 77 million in 2034. With such growth in the population of older Americans, even if the rate of substance use among Americans over the age of 50 stays constant, a spike in the absolute number of SUD cases among older Americans is inevitable as the baby boomers age. And given the unequal nature of American economic and social life, it is essential to consider effects across vulnerable populations rather than the average effect across the general population.

The prevalence of racial and ethnic disparities in morbidity, mortality, access to healthcare, and healthcare quality has been well documented. Such disparities persist even after controlling for socioeconomic conditions (Smedley et al., 2003). Black patients are less likely than white patients to receive adequate medical screening and are more likely to be seen by less trained medical professionals (Fiscella et al., 2000). To a lesser extent, Hispanic patients are also less likely than their white counterparts to receive adequate healthcare. Racial and ethnic disparities in healthcare parallel disparities in other social services (e.g., education, criminal justice, labor). Systemic and institutional racism impact both the type of care racial/ethnic minorities receive conditional on seeking treatment and whether they have access to healthcare to seek treatment at all. Examining SUD treatment by race will not enable us to speak to the factors that contribute to inequitable treatment; however, it will enable us to better identify racial differences in SUD treatment outcomes.

In addition to analyzing SUD treatment admissions and discharges (completion and termination) among older adults in the United States, we investigate these outcomes across race and ethnicity. The opioid abuse epidemic is not the United States's first experience of widespread drug use and addiction, but the country's policy response has differed dramatically from its response during the "war on drugs" era. Stringent sentencing and vehement drug criminalization in the 1980s and 1990s proved ineffective and racially biased toward Black and Hispanic communities (Editorial Staff, 2020). Given the historical mistreatment and marginalization of minorities in the United States, we must investigate the efficacy of SUD treatment admissions and discharges historically and in the present day.

Furthermore, race and ethnicity may play a mitigating role in an individual's likelihood of completing SUD treatment. Using 2011 data, Mennis and Stahler (2016) find that Black and Hispanic patients are less likely than other patients to complete SUD treatment. This result holds for Black individuals across all substance types. The authors echo other researchers calling for "culturally appropriate" SUD treatment to boost retention and completion. Using Los Angeles County data from 2006 to 2009, Guerrero et al. (2013) also find that Black and Latino patients are less likely to complete treatment than their white counterparts. They also identify heterogeneity within racial and ethnic groups, which further motivates our analysis of race/ethnicity's role in treatment outcomes for SUDs. Nevertheless, it is unclear whether this effect has persisted over time or merely exists during the limited time frame explored in these studies.

The analysis presented in this paper is critical given the stark demographic differences between past and present drug epidemics, particularly the crack cocaine and opioid epidemics (Case & Deaton, 2015). By examining the primary substance type at admission, we explore distinctions in the type of substance use across race and ethnicity. To complement our analysis, we also explore differences across gender.

It has been well established that men use substances and seek SUD treatment at higher rates than women (National Institute on Drug Abuse, n.d.). However, admissions for women have grown by roughly 300,000 over a twenty-six-year span. In 1992 female admissions accounted for 28% of all admissions, while in 2017, they accounted for 36% Substance Abuse and Mental Health Services Administration (2018). We show this growth in admissions over time across gender in Fig. A1 of the Appendix.

Gender presents a unique set of obstacles when discussing substance use; this is true for the opioid epidemic as it was for past drug epidemics. For instance, women have the most significant risk for opioid abuse, as they experience chronic pain and are prescribed pain medication at higher rates than men. According to Mack et al. (2013), the United States death rate from 1999 to 2010 for prescription opioids rose to 400% for women compared to 237% for men. In an overview of research on substance use in women the National Institute on Drug Abuse (n.d.) established that women "often use drugs differently, respond to drugs differently and can have unique obstacles to effective treatment as simple as not being able to find child care or being prescribed treatment that has not been adequately tested on women."

The bulk of recent research on SUD treatment focuses on the effects of Medicaid expansion, prescription drug monitoring programs, and other opioid-specific policies in the interest of informing policymakers (Ellyson et al., 2020; Grooms & Ortega, 2019; Maclean & Saloner, 2017). This paper, however, serves a more descriptive purpose, contextualizing policy effects within the nation's narrative on substance use treatment across demographic groups. We are interested in how SUD treatment admissions and completions differ by race/ethnicity relative to white residents. We also examine how these effects differ with age and by substance type. Unlike other studies that focus on shorter time frames, we compare estimated effects over an extended period to determine whether differences or inequities are driven by a single year and whether trends are changing. Specifically, this paper makes two key contributions to the literature:

1. It explores SUD treatment admissions trends among older adults by race and ethnicity, focusing on the past three decades (1992–2017).
2. It analyzes variation in completion and termination of treatment by race/ethnicity and gender across age groups and over time (2006–2017).

2. Analytical plan & methods

2.1. Treatment and discharge data

The bulk of our data is from the Treatment Episode Data Set–Admissions (TEDS-A), made accessible by the Substance Abuse and Mental Health Service Administration (SAMHSA). TEDS-A collects and compiles annual admissions to substance abuse treatment for all treatment facilities that receive any federal funding. It does not include facilities operated by federal agencies, such as Veteran Affairs or prisons. The data collection process dates back to 1992 and has continued annually since. It comprises more than 48 million observations that account for approximately two-thirds of the entire population of treatment admissions (Dave & Mukerjee, 2011). The data include various demographic information collected from patients at the point of admission into treatment facilities. This paper makes particular use of age, race/ethnicity, gender, and primary substance used at time of admission. Evidence suggests that some substances are used at different rates in different racial/ethnic subgroups (Case & Deaton, 2015). This dataset affords us the ability to explore these established differences without compromising computing power.

In 2018, over 60% of all admissions reported in TEDS-A had at least

one prior treatment episode (Substance Abuse and Mental Health Services Administration, 2019). Admissions data fails to provide details in time during treatment, so we incorporate discharge data from Treatment Episode Data Set–Discharge (TEDS-D) from 2006 to 2017 to capture the full picture. TEDSD includes more than 19 million observations across variables comparable to those captured in TEDS-A. Each observation is an admission into SUD treatment, for which discharge data is also collected. Discharge data are available for roughly 78% of all admissions during the study period. Because we combine the two datasets, we can explore who is receiving treatment and who is completing treatment. This information is vital given that completion of treatment is associated with improved health and employment outcomes (Zarkin et al., 2002). Thus, TEDS grants us the ability to investigate admissions and estimate the probability of completion or termination by race/ethnicity.

Both TEDS datasets use 18 categories to identify the primary substance used at the time of admission. We offer insight into treatment episodes for five of the most prevalent substances in the data: alcohol, crack/powder cocaine, heroin, prescription opioids, and methamphetamines. These five categories include over 75% of all observations found in both datasets, with alcohol typically accounting for more than one third of treatment episodes. We collect data on state demographics using the University of Kentucky Center for Poverty Research (UKCPR) and the Surveillance, Epidemiology, and End Results (SEER) datasets.

A critical distinction between TEDS-A (admissions data) and TEDS-D (discharge data) is that states must report the data collected in TEDS-A. Consequently, more states have data regularly missing from TEDS-D compared to TEDS-A. In 2006, 10 states did not report any discharge data. Conversely, in 2013, Mississippi and New Mexico were the only states that did not report any data. While the non-reporters vary by year, Washington D.C., Georgia, Mississippi, New Mexico, Pennsylvania, and West Virginia are repeat offenders; all are missing discharge data for at least six years.

2.2. Analytical plan

We employ two methods to analyze the data. First, we plot the unconditional number of SUD treatment admission and discharge trends over time. We stratify our results by race, ethnicity, and gender. We also consider differences across substance use types. We then employ regression models to examine differences in treatment outcomes (i.e., discharge outcome). Our admissions data (TEDS-A) spans from 1992 to 2017; our discharge data (TEDS-D) spans from 2006 to 2017. We are interested in demographic differences in likelihood of treatment completion or treatment termination among treatment admissions age 50 and older; we are also interested in whether we see similar differences among discharges under 50 years of age.

2.3. Methods

We consider SUD treatment outcomes across race/ethnicity and age. Our primary focus is to determine whether racial, ethnic, or gender differences exist among elderly admissions and whether these results differ from demographic differences among younger discharges. Our analysis examines whether (1) racial, ethnic, or gender differences in treatment outcomes exist within age groups and (2) whether differences in treatment outcomes exist across age groups but within race, ethnicity, or gender. We focus on the likelihood of two treatment outcomes observed in our data after conditioning on demographic characteristics: completing treatment or termination from treatment. We use the following model:

$$y_{ist} = \alpha + \beta_1 \mathrm{Black}_{ist} + \beta_2 \mathrm{Hispanic}_{ist} + \beta_3 \mathrm{Male}_{ist} + X_{ist}\gamma + {}_{ist}, \quad (1)$$

where y_{ist} is an indicator equal to 1 if person i completed (or was terminated from) treatment in state s at time t, and zero otherwise. Given the dichotomous nature of our outcomes, we report the odds ratios from running logistic regressions. The vector X_{ist} contains dichotomous indicators for high school education, employment status, service setting,[1] frequency of use, referral source, and prior treatment episode, as well as state and year fixed effects. We also control for state-level demographics. In the results presented below, we stratify our analysis by race and age group. We compare outcomes for Black and Hispanic (relative to white) discharges and examine discharges within two age groups: under 50 years old, and 50 years and older. Our results are not comparable across these two groups. Instead, we are interested in disparities that may exist within each of these groups. We consider age differences within racial groups as well.

We code discharges as one of four events: completed, dropped out, terminated by the facility, or deceased. Of the 1.6 million discharges in 2017, roughly 41% completed treatment, 26% dropped out, and 6% were terminated by the facility. We eliminate 22% of discharges from the data because they were transferred to another treatment program facility. We cannot capture what facility these patients were transferred to; therefore, we drop them from our data to eliminate any chance of double counting. An additional 5.6% were either incarcerated, deceased, ill, moved, or exited treatment for some other reason that is not captured by the data.

3. Results

3.1. Trends in admissions

Nominally, most admissions and discharges for SUDs are under the age of 50, but the over 50 population is significant. Roughly 11% of admissions and 16% of discharges in the data are for patients over 50 years old. Figs. 1a–3 partition the number of admissions for all substances into two bins–under 50 years old, and 50 years and older–and stratify the sample by race.[2]

The age of 50 is significant for two reasons. First, it captures the baby boomer population, which is predicted to have a higher rate of substance use than prior birth cohorts. The first wave of baby boomers turned 50 years old in 1996, and the last wave was 53 years old in 2017. While the data are not restricted to baby boomers, we presume a substantial portion of admissions over age 50 are baby boomers. Secondly, TEDS data do not differentiate age after 55 years old.

In Fig. 1a, trends for all admissions (TEDS-A) are mapped from 1992 through 2017. The trend for admissions among those over the age of 50 has steadily climbed over the past two decades. Admissions for whites over 50 have more than tripled from 1992 to 2017, while Black admissions quadrupled and Hispanic admissions nearly doubled. The trend is less clear for admissions under the age of 50. Admissions of whites under the age of 50 increased from 1992 to 2009, then declined for the next five years. In 2015, admissions of whites younger than 50 began to trend upward again, which might be attributed to the expansion of Medicaid (Grooms & Ortega, 2019; Maclean & Saloner, 2017). By contrast, Black admissions were relatively stable from 1992 through 2008. From 2008 through 2014, younger Black admissions declined. Trends in Black admissions under 50 are starkly different from those for Black admissions over 50. Admissions identified as Hispanic and younger than 50 gradually increased from 1992 until 2006, followed by a gradual decline until 2015. To provide context for the nominal trends, on average, for all admissions, Black patients are overrepresented in admissions compared to the overall population in every year from 2007 to 2017. White admissions are underrepresented relative to the United States population across the same period (Substance Abuse and Mental

[1] "Describes the type of service and treatment setting in which the client is placed at the time of admission or transfer" Substance Abuse and Mental Health Services Administration (2018).

[2] Note that scales are not the same within or across figures throughout the paper.

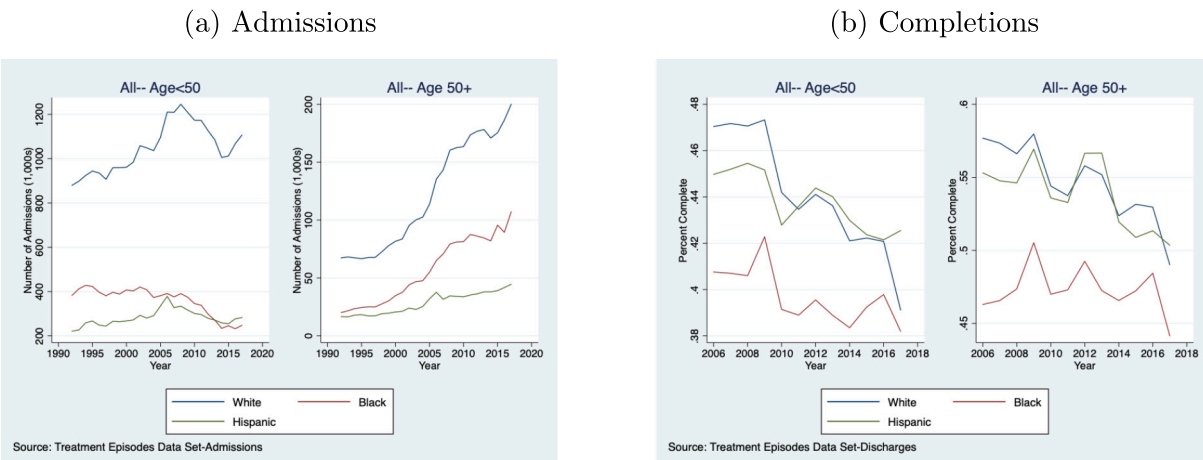


Fig. 1. SUD treatment admissions and completion by age and race/ethnicity.

Health Services Administration, 2017).

Admissions to SUD treatment are on the rise for people over 50, but the share of treatment completion is declining for all age groups across race/ethnicity, as shown in Fig. 1b. The Black completion rate for all substances is the lowest for both age groups throughout the study period. For most years, white and Hispanic completion rates are similar over time. Interestingly, the most precipitous decline for white and Black admissions occurs in 2016.

We further assess trends in admissions and completion rates by substance type, stratified by race/ethnicity. Fig. 2a–d disaggregate trends from Fig. 1a to observe variations in trends at the substance-race/ethnicity level. Differences in substance use trends by race are evident when stratifying by substance type. Trends in alcohol admissions, as shown in Fig. 2a, closely mimic the overall trends shown in Fig. 1a. Trends for other substances vary drastically across groups. This variation is particularly evident in Fig. 2b, which shows that Black admissions

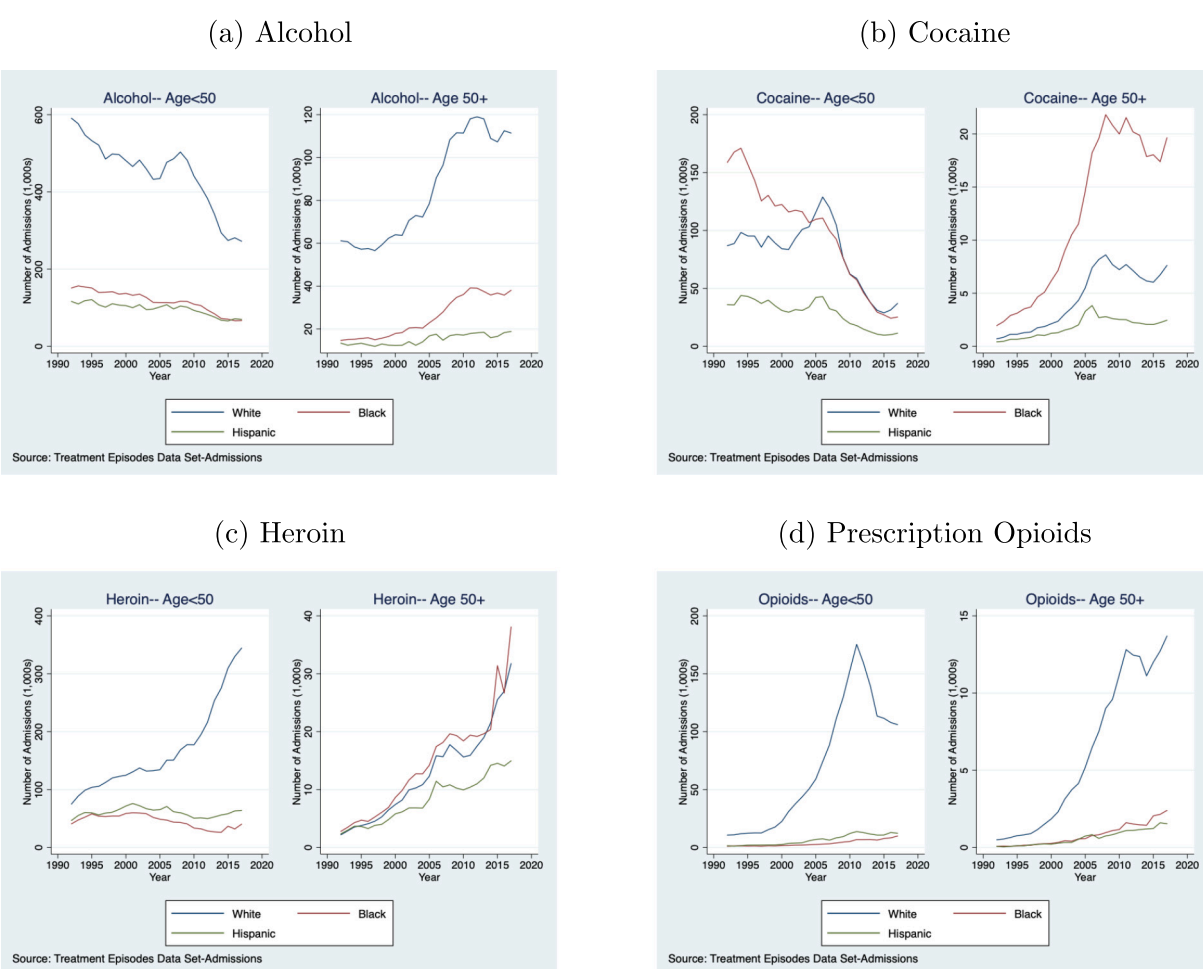


Fig. 2. Trends in admissions by substance type.

for cocaine use make up the greatest number of admissions for most years across both age groups, even though the Black population makes up only 13.4% of the United States population.

Fig. 2d, which shows admissions for abuse of prescription opioids, demonstrates that there is a sharp increase in white admissions across both age groups over time. The slight increase in prescription opioid admissions for Black and Hispanic patients pales in comparison. Fig. 2d mirrors trends established in the opioid epidemic literature. Worryingly, the trend in admissions for prescription opioids among those over 50 has not declined in recent years, despite many efforts (e.g., prescribing limits, prescription drug monitoring programs (PDMPs)) to combat the opioid epidemic.

Although the number of admissions by substance type does fluctuate across racial/ethnic groups, Fig. 2a–d, showing admissions trends for those over 50, closely follow the trends displayed in Fig. 1a: that is, for the most part, admissions increase steadily for the over-50 age group. Distinct trends in completion rates by substance type and race/ethnicity over time are less apparent among those over 50. Fig. 3a and b show that, for both the over0 and under-50 age groups, Hispanic admissions have the highest completion rates for alcohol and cocaine, a trend that persists over time. Yet, completion rates for Hispanic patients still trend downward.

Given the current opioid epidemic, the persistent downward trends in completion for prescription opioids among both age groups, as shown in Fig. 3d, are concerning and require more careful assessment. Unfortunately, this concern is beyond the scope of this paper, although we do discuss relative treatment completions for prescription opioids in the regression analysis section.

3.2. Regression results by race, ethnicity, and age

Tables 1 and 2 investigate the likelihood of completing treatment; that is, completing the planned course of treatment as opposed to being asked to leave, being terminated, leaving against medical advice, passing away, or leaving for some other reason. Table 1 displays odds-ratios from Eq. (1) for Black and Hispanic (relative to white) completion for those 50 or older. Column (1) estimates the likelihood across all substances, and columns (2)–(6) separate the effect by substance type. When controlling for individual characteristics, the odds for Black patients over the age of 50 to complete treatment are about 20% lower than the odds for similarly aged white patients. For Hispanics, the odds are about 14% lower compared to whites. From 2006 to 2017, treatment among blacks over 50 was significantly less likely to be completed when it was sought for alcohol, cocaine, and methamphetamine as the primary substance. Among older Hispanics, treatment episodes were significantly less likely to be completed when treatment was sought for heroin or methamphetamine as the primary substance.

Table 2 column (1) estimates that among the treatment population under the age of 50, both Black and Hispanic admissions are significantly less likely to complete treatment than their white counterparts. The odds for Black patients under the age of 50 to complete treatment are about 15% lower than the odds for similarly aged white patients and about 6% lower than those for Hispanics: this significant decrease in completion rates persists across all substances except heroin. For Hispanics younger than 50, this result is persistent for heroin and methamphetamine, as was the case for Hispanics older than 50. Black and Hispanic admissions are statistically never more likely than whites to complete a SUD treatment for any substance type, across all ages.

Tables 3 and 4 report estimates for terminations from SUD treatment by age, race, and substance type. Both younger and older Black SUD admissions are more likely to be terminated from treatment than white admissions in the same age group. The likelihood for Black patients over and under 50 to be terminated from treatment are about 25 and 18% higher than the likelihood for similarly aged white patients, respectively. The largest effect for both age groups is when alcohol is the primary substance. Termination results are less pronounced for Hispanics under 50. However, the odds of Hispanic admissions over 50 being terminated are 9% greater than for white admissions in the same age group.

To examine how these effects have changed over time and to ensure that no one year or group of years is driving the results, we plot the odds-ratio estimates with 95% confidence intervals from Eq. (1) for each year in our sample, as shown in Figs. 4–6. Fig. 4 plots estimates for Black and Hispanic treatment outcomes relative to white outcomes. For Black individuals, the results are not driven by any one year. However, there is a clear upward trend in relative completion rates for Black admissions under 50 years of age. The disparity in completion seems to dissipate over the most recent years of our analysis. Conversely, older Black admissions are less likely to complete treatment (relative to whites in the same age group) for every year in our sample. Similarly, for younger Hispanics, we observe a decrease in the completion rate disparity over time that we do not observe for older Hispanic individuals.

Fig. 5 depicts a stark difference in terminations for Black individuals. The estimates show that Black admissions of all ages are significantly more likely than whites to be terminated by a treatment facility for every year of the data. Hispanic admissions under 50 are more likely to be terminated for only the last two years of our sample. Hispanics over 50 are significantly more likely to be terminated from treatment than whites, particularly during our sample's most recent years.

In Fig. 6, we compare completions and terminations by race/ethnicity across age groups. For instance, the top left panel plots the odds-ratio estimates of the relative completion rate of Black patients 50 and over relative to Black patients younger than 50. These figures clearly show that older minorities are more likely to complete treatment and less likely to be terminated than younger minority patients. We observe more distinct and persistent differences between age groups for white patients (Fig. A2).

3.3. Regression analysis by gender and age

We now report the estimates for males relative to females using Eq. (1) for each year of our sample. We summarize our results using Figs. 7 and 8. In Fig. 7, we see that males are consistently 6–10% more likely than females to complete treatment for all years in our sample across age groups. For terminations, we see little to no difference between males and females, particularly in more recent years. In Table A4 of the Appendix, we see that the differences in completion among the older age group are being driven by those seeking treatment for alcohol and cocaine. We see similar differences in the younger age group when we add a difference for heroin.

Fig. 8 examines whether there are differences across age groups but within each gender. From 2006 to 2012, males in the older age group were relatively more likely to complete treatment; however, we see that this difference is not as precise in the most recent years of our sample. Fig. 8 also shows that males in the older age group are less likely to be terminated by a substance use treatment facility. For females, we see little difference between the older and younger groups for completions and terminations. Table A4 stratifies the termination results by substance type; we find little difference in termination between male and females with the exception of methamphetamine discharges for individuals younger than 50 years of age.

3.4. Regression analysis by generation

Our focus on treatment outcomes for older relative to younger individuals leads to a natural question of whether differences in treatment completion or termination differ across demographic cohorts, namely

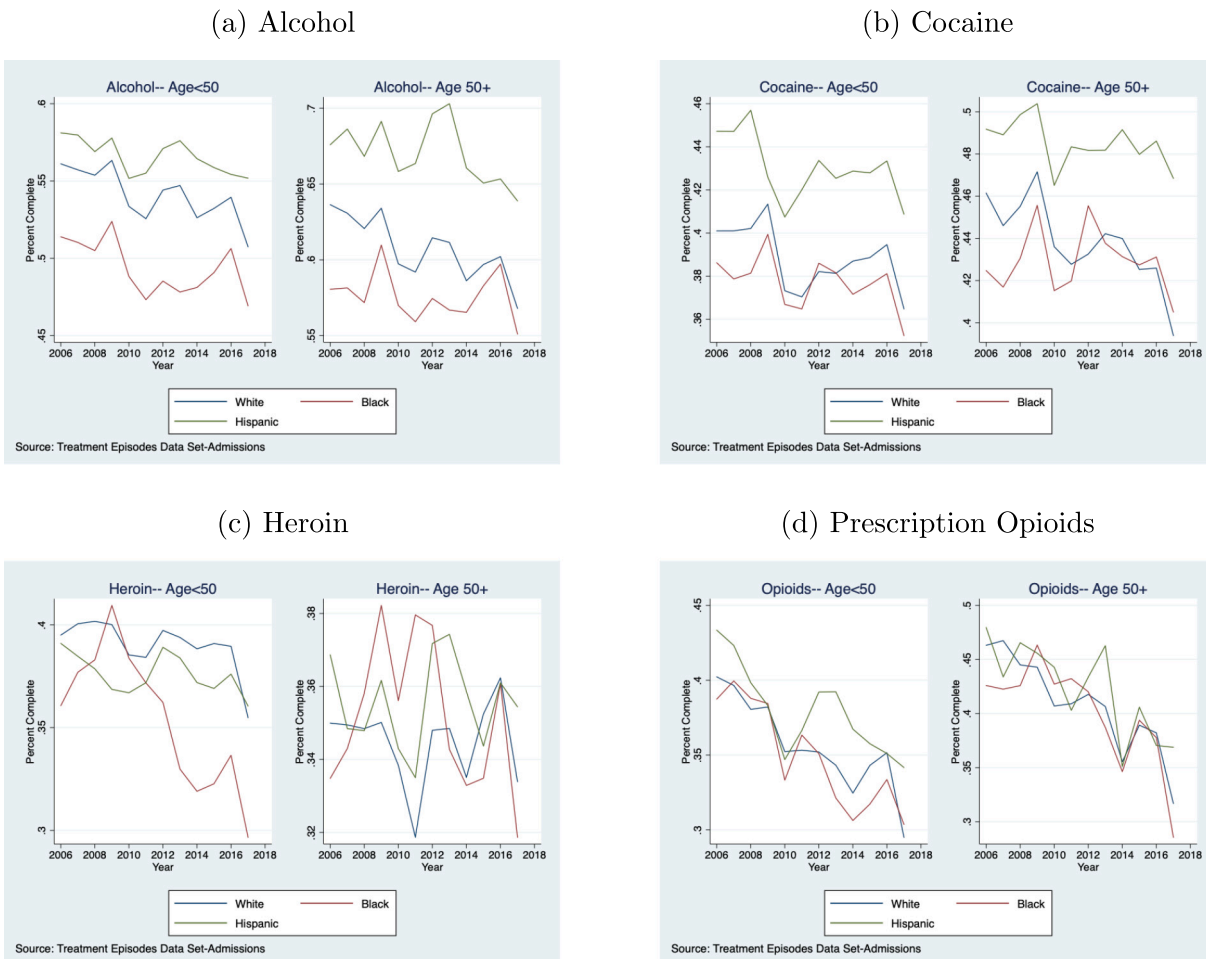


Fig. 3. Trends in completion rates by substance type.

Table 1
Age 50+ likelihood of completion (2006–2017).

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Meth	Opioids
Black	0.803***	0.865**	0.925**	1.051	0.815***	0.943
	(0.0345)	(0.0392)	(0.0237)	(0.0521)	(0.0287)	(0.0592)
Hispanic	0.855**	0.999	1.053	0.947**	0.904***	0.971
	(0.0429)	(0.0410)	(0.0517)	(0.0190)	(0.0113)	(0.0432)
N	2,113,216	1,235,500	232,198	347,545	91,218	92,328

This table reports the odds-ratio coefficient estimates from Eq. (1), where the outcome is whether an individual 50 years or older completed treatment. Black and Hispanic estimates are relative to white estimates.

*** $p < 0.01$.

** $p < 0.05$.

Generation X, Generation Y, and Generation Z. We do not focus on this as the main specification due to data limitations. TEDS-D bins age groups (e.g., ages 30–34), so we cannot identify a specific age for an individual undergoing substance use treatment.[3] For most years, the oldest age category is "55 and over." Thus we are unable to provide any insight into the baby boomer generation. In categorizing each demographic cohort, the binned age groups in TEDS-D also overlap in each Generation's coding. For instance, in 2011, an individual in Generation X would be between the ages of 31 and 46; an individual in Generation Y would be between the ages of 15 and 30. Thus the age category 30–34 in TEDS-D would capture individuals from both of these groups. Nonetheless, we create the three demographic cohort indicators, Gen X, Gen Y, and Gen Z, for individuals born in the years 1965–1980 (X), 1981–1996 (Y), and 1997–2012 (Z), respectively. Whenever there is an overlap, we include each age bin as part of the overlapping generation. For instance, an individual in TEDS-D between the ages of 30–34 is captured in both the Gen X and Y indicators.

Fig. 9 reports the odds-ratio estimates and 95% confidence intervals

[3] For the years 2006–2014 the age groups are as follows: 12–14, 15–17, 18–20, 21–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55 and over. For the years 2015–2017 the bins 55–64 and 65 and older are added in TEDS-D.

Table 2
Age < 50 likelihood of completion (2006–2017).

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Meth	Opioids
Black	0.851***	0.814***	0.901***	1.098	0.814***	0.940
	(0.0247)	(0.0311)	(0.0273)	(0.0588)	(0.0345)	(0.0353)
Hispanic	0.936**	1.004	1.012	0.874***	0.932***	0.973
	(0.0227)	(0.0346)	(0.0432)	(0.0330)	(0.00913)	(0.0406)
N	10,575,860	3,664,553	991,852	1,661,050	1,001,147	816,489

This table reports odds-ratio coefficient estimates from Eq. (1), where the outcome is whether an individual younger than 50 years of age completed treatment. Black and His-panic estimates are relative to white estimates.

*** $p < 0.01$.

** $p < 0.05$.

Table 3
Age 50+ likelihood of termination (2006–2017).

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Meth	Opioids
Black	1.252***	1.220***	1.067***	1.006	1.293	1.168**
	(0.0369)	(0.0309)	(0.0202)	(0.0285)	(0.180)	(0.0671)
Hispanic	1.097***	1.024	0.997	0.971	1.224*	0.939
	(0.0252)	(0.0256)	(0.0577)	(0.0364)	(0.0974)	(0.0615)
N	1,688,705	1,067,348	180,831	233,201	39,346	70,786

This table reports odds-ratio coefficient estimates from Eq. (1), where the outcome is whether treatment for an individual 50 years of age or older was terminated by a facility. Black and Hispanic estimates are relative to white estimates.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.10$.

Table 4
Age < 50 likelihood of termination (2006–2017).

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Meth	Opioids
Black	1.186***	1.259***	1.065*	0.975	1.161***	1.156**
	(0.0310)	(0.0341)	(0.0286)	(0.0446)	(0.0498)	(0.0546)
Hispanic	1.050	1.009	1.050	0.990	1.112***	1.019
	(0.0320)	(0.0466)	(0.0499)	(0.0154)	(0.0260)	(0.0510)
N	8,420,870	3,132,130	815,047	1,323,931	498,977	693,355

This table reports point odds-ratio coefficient estimates from Eq. (1), where the outcome is whether treatment for an individual younger than 50 years of age was terminated by a facility. Black and Hispanic estimates are relative to white estimates.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.10$.

for the Black, Hispanic, and male (relative to female) variables in Eq. (1). We stratify the results from Eq. (1) by generation. We see that across generations, Black and Hispanic admissions are less likely to complete treatment relative to their white counterparts. We see that males in Gen X and Gen Y are more likely to complete treatment relative to their female counterparts. Interestingly, this result dissipates among Gen Z admissions. For terminations, Black individuals are more likely to be terminated from treatment. This result is especially substantial for Generation Z. Among Generation Z, the odds of Black admissions being terminated were about 50% higher than the odds for whites. Similarly, for Hispanic admissions, the termination result is only evident for Generation Z. The same is true when examining males relative to females.

3.5. Cross age-race comparison

We also consider a specification where we amend Eq. (1) by interacting the race, ethnicity, and gender dummy variables with an indicator of whether an individual was age 50 or older.[4] Tables A5 and A6 report these results. Similar to our baseline estimates, we see disparities

[4] We use the following specification

$$yis = \alpha s + \beta 1Blackis + \beta 2Hispanicis + \beta 3Over50 + \beta 4Blackis \times Over50 + \beta 5Hispanicis \times Over50 + \quad (2)$$

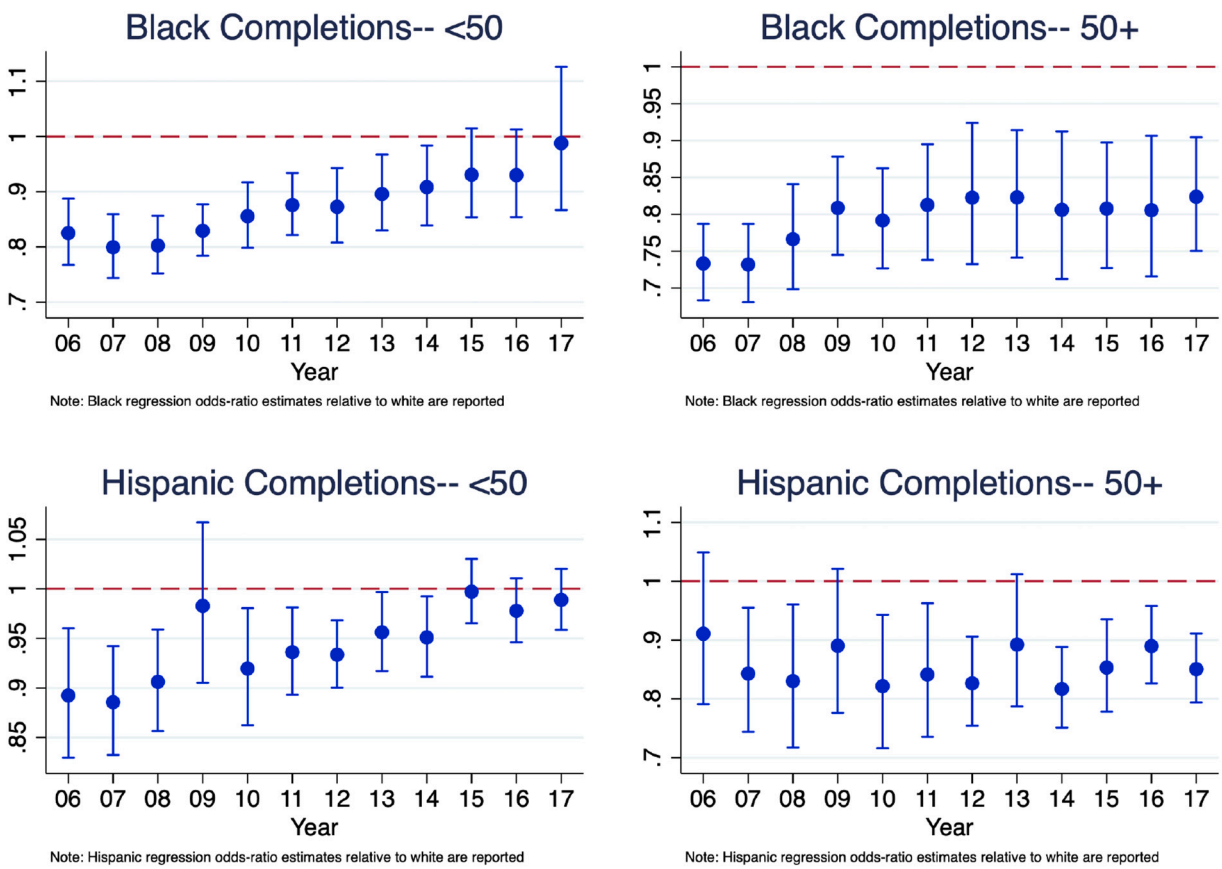


Fig. 4. Completions for Black and Hispanic admissions compared to white admissions.

across race and ethnicity and less so across gender, evidenced by the race dummy coefficients. Interestingly, we do not see as significant effects for the race/ethnicity-age-over-50 interaction terms. However, it is important to note that this regression compares older black/Hispanic individuals to their white counterparts. We do not include this as one of the paper's main specifications because the point estimates on the interaction terms would be conflating two issues: age and race. Younger individuals are much more likely to engage in risky behaviors. Thus, finding (or not finding) a result of this interaction would not precisely pinpoint whether there exists a disparity (or lack thereof) because we would not know whether to attribute these results to age or race. Moreover, the lack of statistical precision on the variables *Black* × *Over*50 may also be concerning: why are riskier (white) youth not more likely to be terminated than minorities over 50 years of age?

4. Discussion

4.1. Summary of results

Our descriptive and regression analyses grant us the ability to explore the landscape of SUD treatment admissions and discharges over a long period of time. This exploration shows that Black and Hispanic admissions are less likely to successfully complete SUD treatment than white admissions. Black patients are also more likely to have their treatment terminated by a substance use treatment facility. Interestingly, the disparity in completions dissipates for those under 50 in the most recent years of our sample (2015–2017). However, differences in SUD treatment completion rates by race/ethnicity are consistently prevalent among those aged 50 and over for every year in our sample. The differences seem to also persist across demographic cohort generations (e.g., Gen X). We also find that males are more likely to complete treatment than females over the time of our study. This analysis raises two important policy concerns: 1) public health equity among older adults across racial/ethnic groups, and 2) financial and social implications of the increased prevalence of SUDs among older Americans.

4.2. Limitations

Taken together, our data offer a substantial benefit in that they are standardized across all years, but they also have limitations. First, SAMHSA did not collect extensive data on completions and terminations of treatment prior to 2006; as a result, data on discharges, which provide a proxy for treatment efficacy, do not cover the full span of the data. Second, each observation represents a single admission or a single discharge. While we can observe the number of prior treatment episodes, we cannot link each admission/discharge with a unique individual in the same year or subsequent years. Throughout the data, roughly 36% of admission observations and 36% of discharge observations had no prior treatment episodes. We also use age 50 as a cutoff given that for some years, TEDS-D does not specify many categories beyond age 50.[5] Another limitation is the capture of cocaine use in one broad category. Crack cocaine and powder cocaine are chemically near identical, but they are not usually seen as substitutes. The two substances have different price points, are consumed differently, have different relapse rates, and are used by different income and racial/ethnic groups (Editorial Staff, 2020). We discuss this distinction in more detail in the results section below.

[5] For many years of this data, the oldest age category is "55 years of age and over."

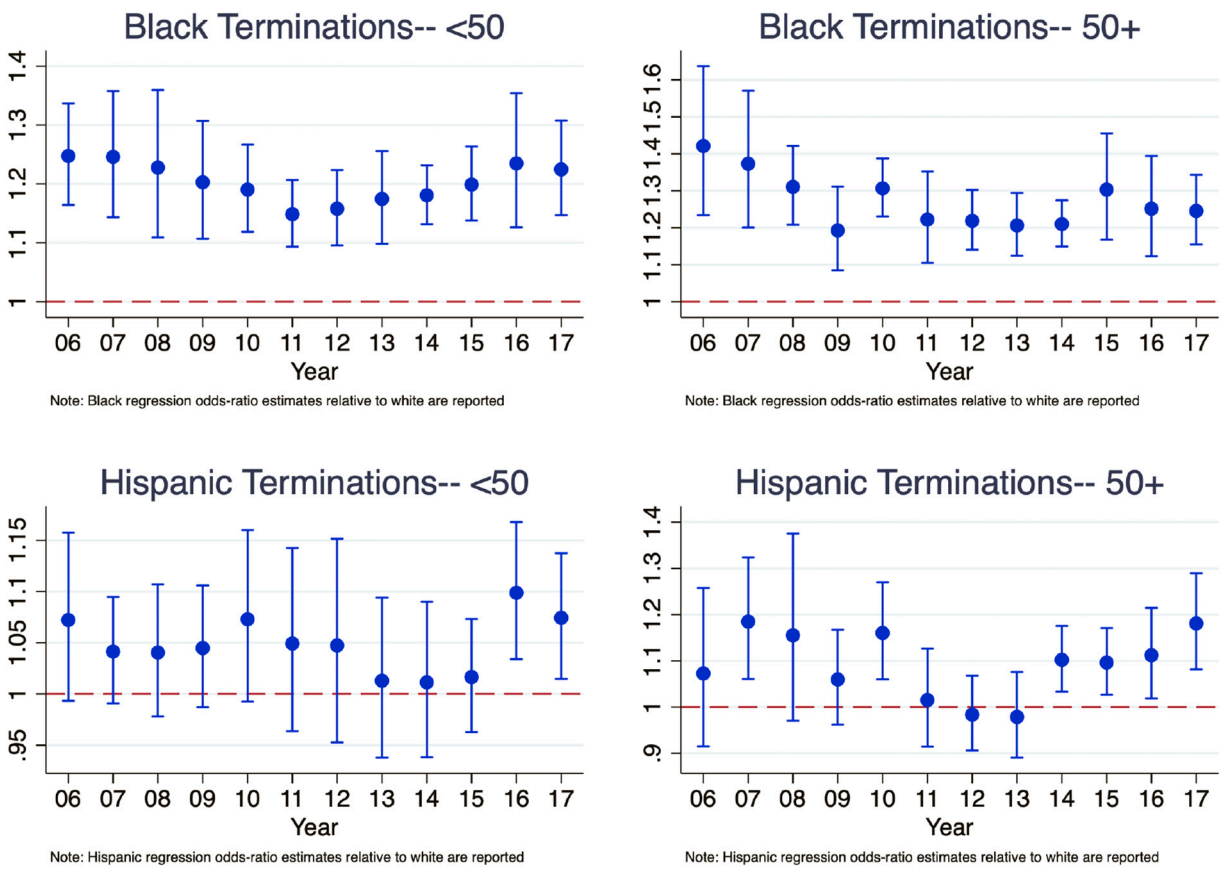


Fig. 5. Likelihood of termination for Black and Hispanic admissions compared to white admissions.

4.3. Implications

While studies of SUDs among older populations are scarce compared to studies of adolescent and middle-age substance use, it is clear that the number of SUD treatment admissions among older Americans has steadily increased. This follows prior predictions made by U.S. Census Bureau (2018), Rothrauff et al. (2011), and Han et al. (2017). But we must understand the population of individuals seeking treatment to ensure the efficacy of care. According to the American Psychiatric Association (2013), older populations have different risk factors than the general population. The relatively high United States life expectancy and the lack of awareness of substance use disorders among older adults make this population vulnerable to complications arising from substance misuse.

We find that SUD treatment admissions of older individuals trend upward across all racial/ethnic groups. Our findings indicate that while Black and Hispanic admissions are less likely to complete SUD treatment than their white counterparts across age groups, in recent years the likelihood of completion for Black and Hispanic admissions is not statistically different from white admissions. The same cannot be said for Black and Hispanic admissions older than 50, who are persistently less likely to complete treatment throughout the study's time frame, from 2006 to 2017. Additionally, given the rise in older admissions, as shown in Fig. 1a, this persistent inequity in the likelihood of completing treatment, shown in Fig. 4, is concerning. This disparity raises a public health equity concern as older Black SUD treatment admissions do well compared to younger Black admissions but worse compared to older white admissions; the same is true for Hispanics.

Although this paper paints a vivid picture of SUD treatment in the United States, it still raises some questions worthy of further research. For example, the connection, if any, between the high number of Black admissions under 50 years of age in the 1990s and the high number of Black admissions over 50 post-2005 (shown in Fig. 2b), is unclear. Given the research on the harsh criminalization of crack cocaine, it is not clear if more recent policies have ever adequately addressed the effects of this deleterious race-based policy.

It is also unclear why admissions for prescription opioid use disorders are increasing for white admissions over age 50 and decreasing sharply for those under 50. These findings suggest that the multiple measures meant to address the opioid epidemic (e.g., Ellyson et al. (2020)) have had little to no effect on older populations. These measures might be under-utilized or less effective among older populations.

Older people are typically not associated with risky behavior such as substance abuse; the rising numbers of SUD admissions in older age groups may indicate a paradigm shift in the risky behavior modeling of older populations. Moreover, while as a nation we are investing heavily in addressing the opioid epidemic– a predominantly white affliction–the findings of this paper suggest that minorities continue to struggle to complete treatment at all ages.

This paper helps lay the foundation needed to better understand the unintended consequences of public policies around substance use. Our findings are also timely given the disparate effects of the Coronavirus pandemic. In addition to the disproportionate number of deaths suffered by communities of color, recent work has also highlighted that racial and ethnic disparities in access to resources and mental health have worsened during the pandemic (Davis et al., 2020; Grooms et al., 2021). Our results may suggest that preexisting disparities in substance use treatment are most likely to be exacerbated during the Coronavirus pandemic.

A deeper understanding of SUD treatment is essential to the growing literature on mental health disparities across race and ethnicity. It has been well established that mental health diagnoses and utilization of mental health services are less prevalent among Black and Hispanic patients (Agency for Healthcare Research and Quality, 2016). Lack of

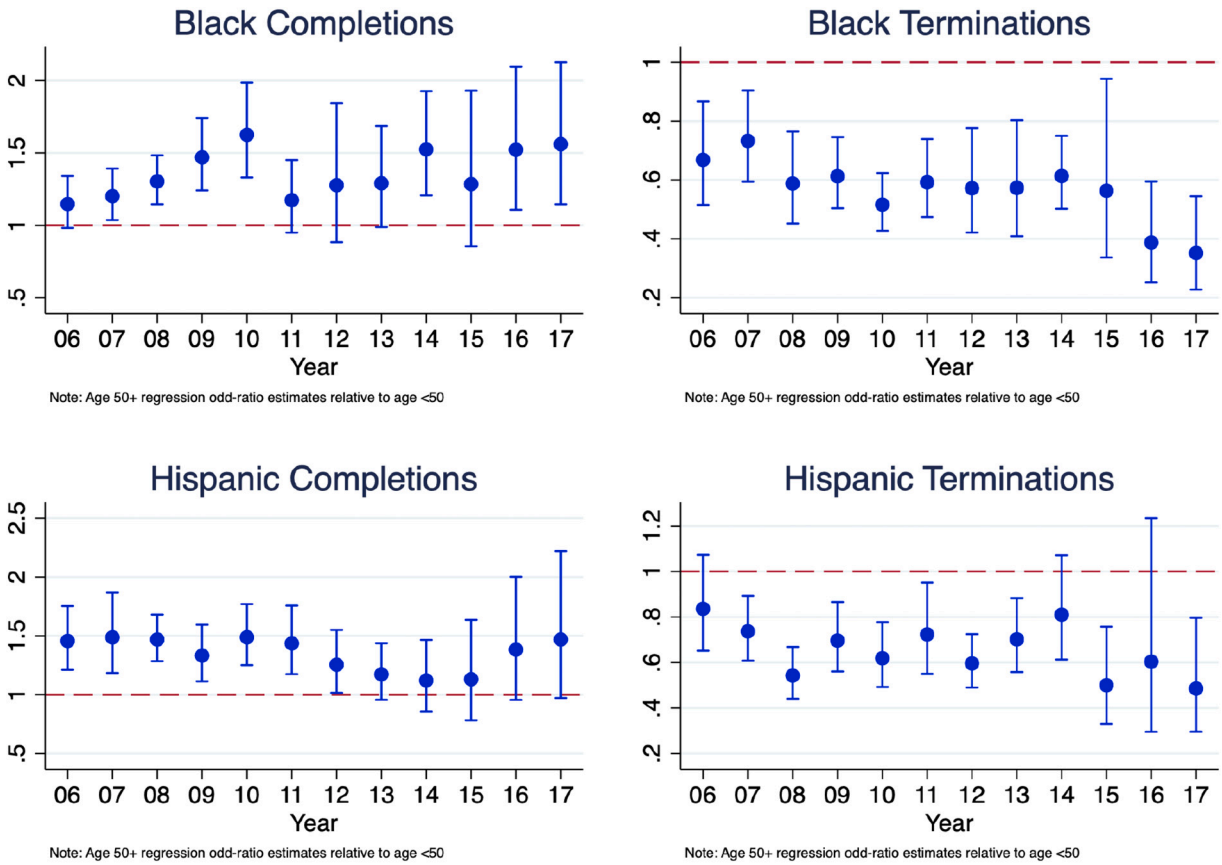


Fig. 6. Completions and terminations of age 50+ relative to age < 50.

insurance, social stigma, distrust, and lack of diversity and cultural incompetence among providers contribute to disparities in healthcare utilization. Our paper highlights the importance of disaggregating the data by race, ethnicity, and gender to avoid race and gender-based policy and ensure that analysis helps inform inclusive policy around substance use disorders (Sharpe, 2019).

CRediT authorship contribution statement

Both authors, Jevay Grooms and Alberto Ortega contributed equally to the manuscript and data analysis involved.

Declaration of competing interest

The authors declare that they know of no conflicts of interest associated with this publication. There has been no significant financial support for this work that could have influenced its outcome.

Appendix A. Appendix

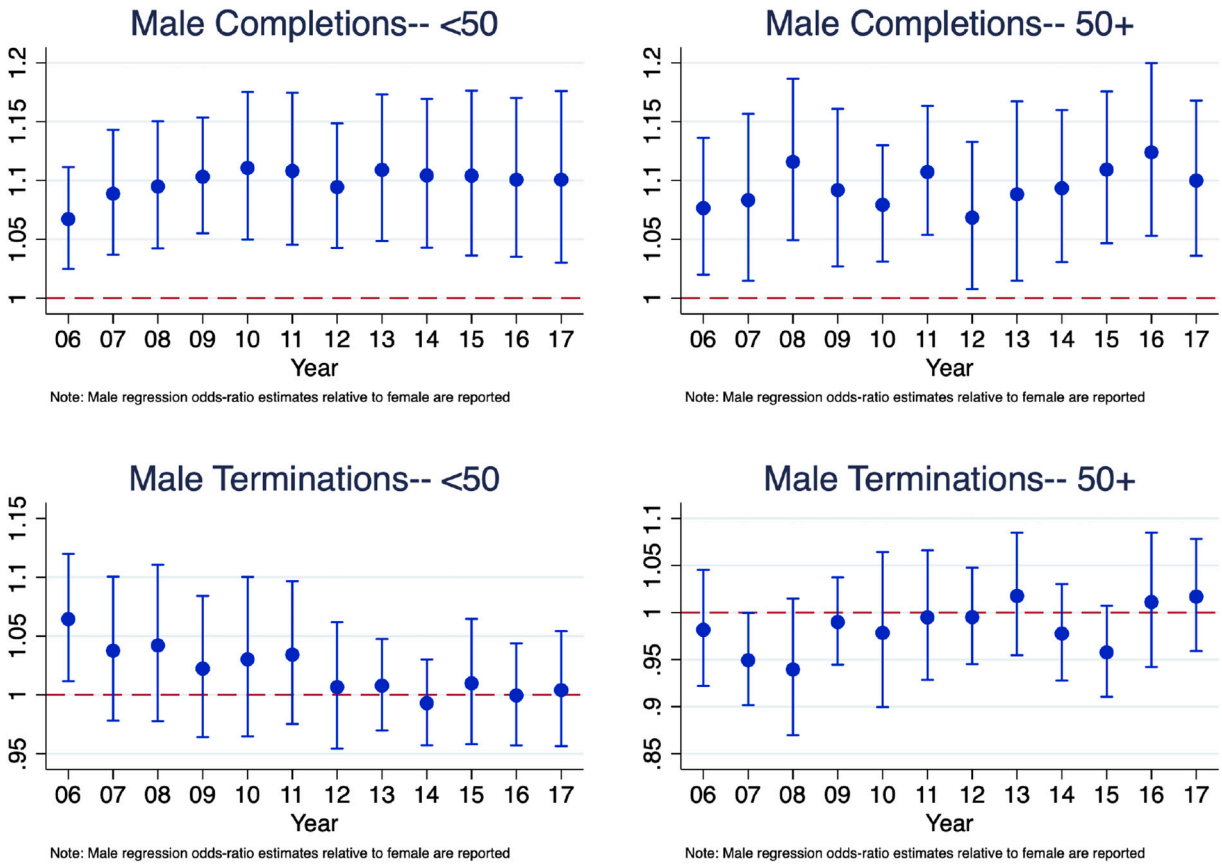


Fig. 7. Completions and terminations for males relative to females.

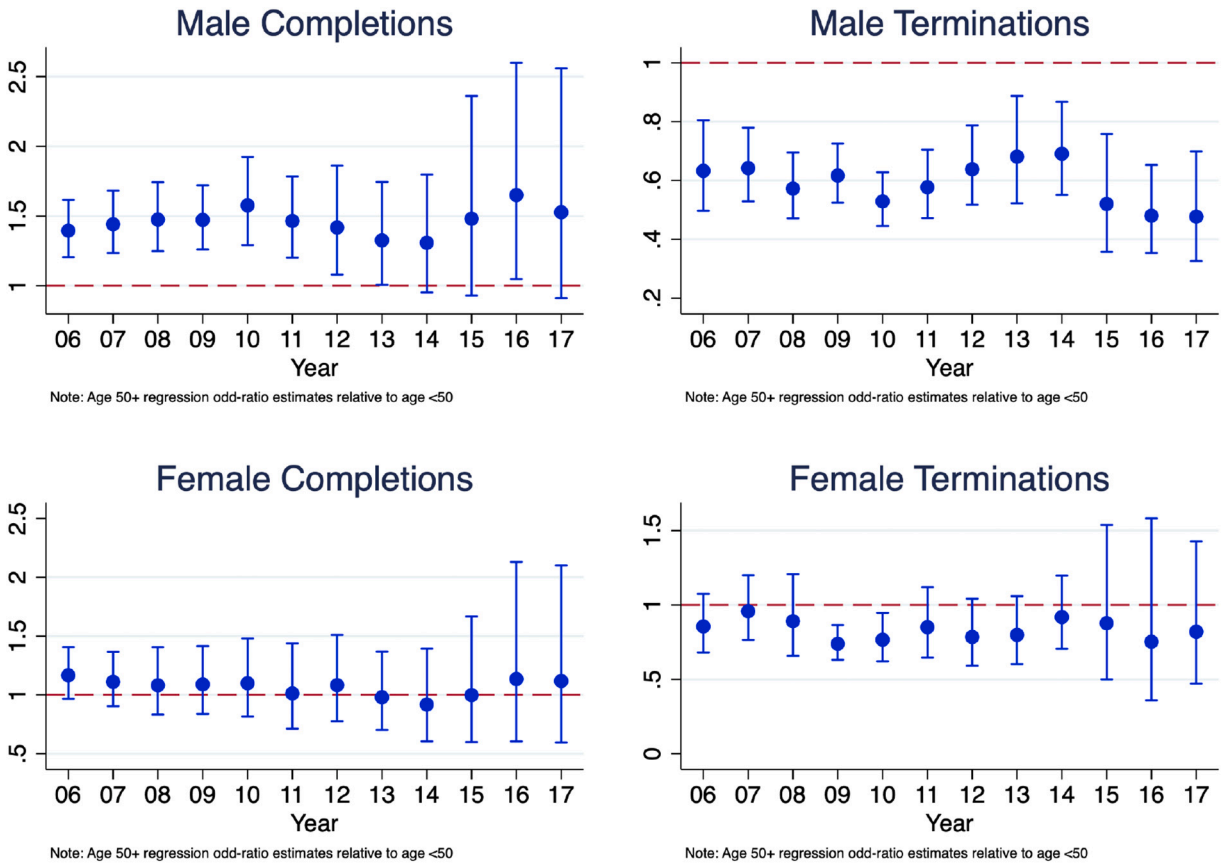


Fig. 8. Completions and terminations for age 50+ relative to age < 50.

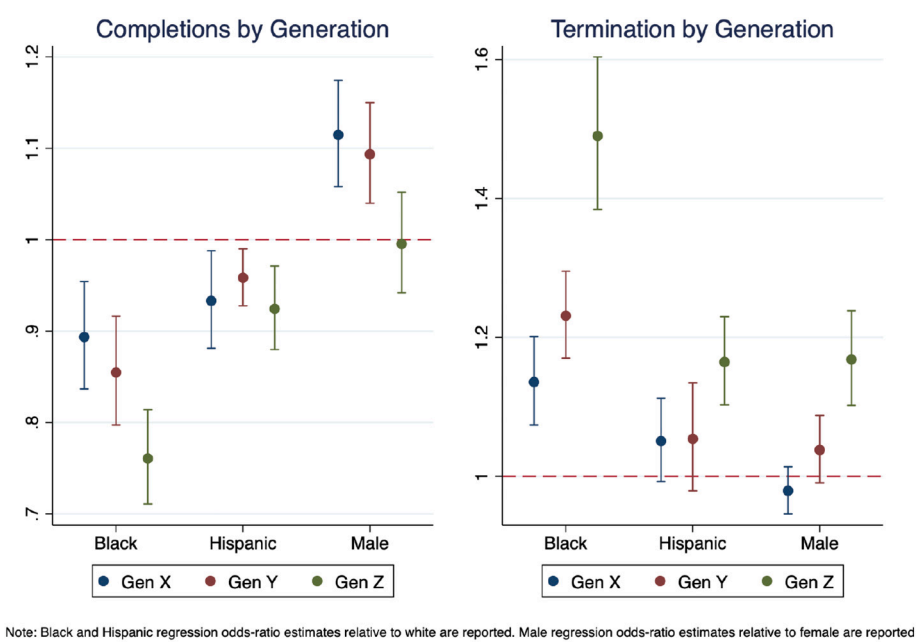


Fig. 9. Completions and terminations by generation.

Table A6
Terminations with interaction terms.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Meth	Opioids
Black	1.183***	1.254***	1.067*	0.985	1.161***	1.156**
	(0.0306)	(0.0323)	(0.0281)	(0.0449)	(0.0501)	(0.0543)
Hispanic	1.054	1.019	1.055	0.991	1.113***	1.020
	(0.0339)	(0.0511)	(0.0525)	(0.0156)	(0.0258)	(0.0512)
Over 50	1.050	1.064***	0.986	1.127**	1.131	1.057
	(0.0274)	(0.0194)	(0.0375)	(0.0423)	(0.0720)	(0.0880)
Black × Over 50	1.066	0.982	1.005	0.962	1.083	0.984
	(0.0370)	(0.0234)	(0.0250)	(0.0447)	(0.158)	(0.0475)
Hispanic × Over 50	1.013	0.964	0.948	0.936	1.087	0.911
	(0.0476)	(0.0635)	(0.0387)	(0.0373)	(0.0907)	(0.0687)
Male	1.027	1.013	1.038	1.027	1.150***	1.012
	(0.0237)	(0.0258)	(0.0345)	(0.0288)	(0.0439)	(0.0236)
Male × Over 50	0.928***	0.935**	0.980	0.949	0.912	1.004
	(0.0190)	(0.0192)	(0.0201)	(0.0293)	(0.0489)	(0.0391)
N	10,109,575	4,213,519	996,580	1,558,743	540,967	764,806

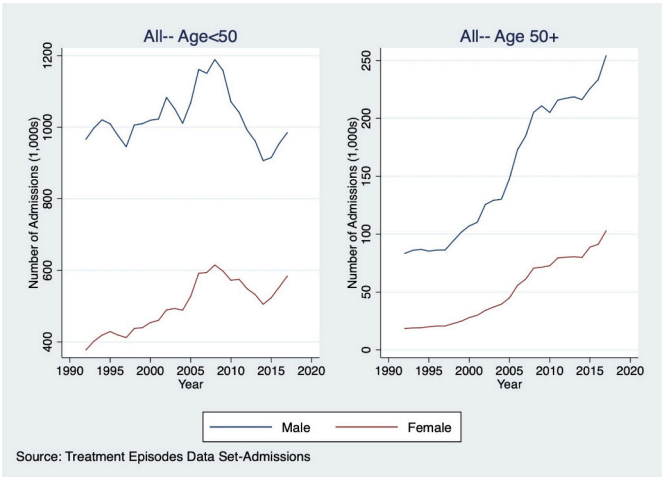
Table A5 reports the odds-ratio coefficient estimates from Eq. (2) where the outcome is whether an individual was terminated from treatment. Black and Hispanic estimates are relative to white. *Over*50 are relative to those under-50.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.10$.

(a) Admissions



(b) Completions

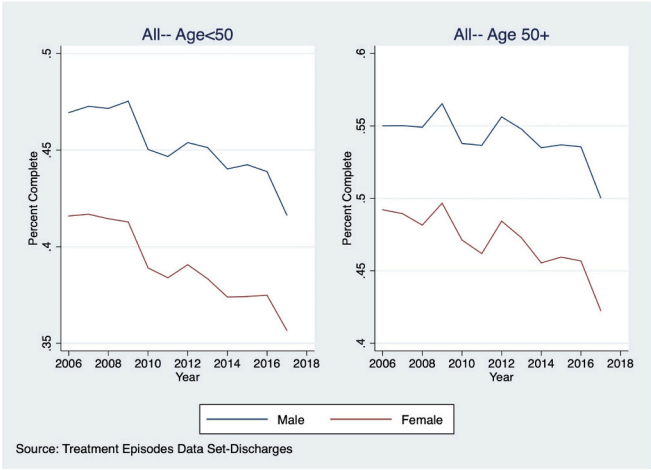


Fig. A1. SUD treatment admissions and completion by age and gender.

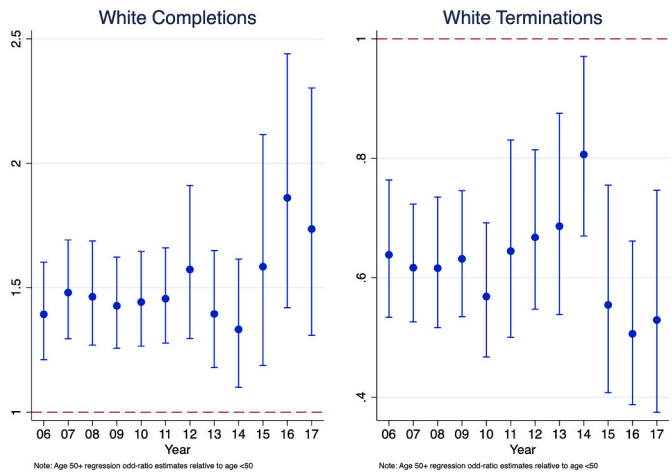


Fig. A2. White completions and terminations of age 50+ relative to age¡50.

Table A1
Likelihood of completion, gender (2006–2017).

Age 50+						
Male	1.093***	1.113***	1.084**	1.020	1.041	1.006
	(0.0272)	(0.0201)	(0.0283)	(0.0136)	(0.0294)	(0.0263)
N	2,113,216	1,235,500	232,198	347,545	91,218	92,328
Age < 50						
Male	1.099***	1.120***	1.076***	1.037**	0.997	1.081*
	(0.0269)	(0.0193)	(0.0214)	(0.0140)	(0.0330)	(0.0357)
N	13,590,068	4,485,947	1,129,529	2,434,909	1,412,286	1,084,256

Table 1 reports the odds-ratio coefficient estimates from Eq. (1) where the outcome is whether an individual completed treatment. Male estimates are relative to female.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.10$.

Table A2
Likelihood of termination, gender (2006–2017).

Age 50+						
Male	0.987	0.968	1.034	1.003	1.061	1.023
	(0.0145)	(0.0162)	(0.0284)	(0.0329)	(0.0506)	(0.0305)
N	1,688,705	1,067,348	180,831	233,201	39,346	70,786
Age < 50						
Male	1.017	1.001	1.030	1.010	1.131***	1.020
	(0.0208)	(0.0225)	(0.0329)	(0.0250)	(0.0342)	(0.0225)
N	10,831,391	3,822,014	933,484	1,942,136	750,561	924,734

Table 1 reports the odds-ratio coefficient estimates from Eq. (1) where the outcome is whether an individual was terminated from treatment. Male estimates are relative to female.

*** $p < 0.01$.

Table A3
Likelihood of completion, gender (2006–2017).

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Methamphetamine	Opioids
Age 50+						
Female	0.915***	0.898***	0.923**	0.981	0.960	0.994
	(0.0228)	(0.0162)	(0.0241)	(0.0130)	(0.0271)	(0.0259)
N	2,113,216	1,235,500	232,198	347,545	91,218	92,328
Age < 50						
Female	0.910***	0.893***	0.929***	0.964**	1.003	0.925*
	(0.0223)	(0.0154)	(0.0184)	(0.0130)	(0.0332)	(0.0305)
N	13,590,068	4,485,947	1,129,529	2,434,909	1,412,286	1,084,256

Table 1 reports the odds-ratio coefficient estimates from Eq. (1) where the outcome is whether an individual completed treatment. Female estimates are relative to male.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.10$.

Table A4
Likelihood of termination, gender (2006–2017).

Age 50+						
Female	1.014	1.033	0.967	0.997	0.942	0.978
	(0.0149)	(0.0173)	(0.0266)	(0.0328)	(0.0449)	(0.0292)
N	1,688,705	1,067,348	180,831	233,201	39,346	70,786
Age < 50						
Female	0.983	0.999	0.971	0.990	0.884***	0.981
	(0.0201)	(0.0224)	(0.0310)	(0.0245)	(0.0267)	(0.0217)
N	10,831,391	3,822,014	933,484	1,942,136	750,561	924,734

Table 1 reports the odds-ratio coefficient estimates from Eq. (1) where the outcome is whether an individual was terminated from treatment. Female estimates are relative to male.

*** $p < 0.01$.

Table A5
Completions with interaction terms.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Alcohol	Cocaine	Heroin	Meth	Opioids
Black	0.850***	0.813***	0.898***	1.095	0.813***	0.939
	(0.0261)	(0.0329)	(0.0273)	(0.0604)	(0.0342)	(0.0352)
Hispanic	0.932**	0.985	1.015	0.881**	0.932***	0.978
	(0.0216)	(0.0328)	(0.0451)	(0.0354)	(0.00963)	(0.0397)
Over 50	0.955	0.903***	0.914***	0.942	0.984	0.953
	(0.0245)	(0.0161)	(0.0250)	(0.0387)	(0.0287)	(0.0291)
Black × Over 50	0.950	1.076***	1.048*	1.005	1.013	1.019
	(0.0277)	(0.0206)	(0.0221)	(0.0371)	(0.0291)	(0.0418)
Hispanic × Over 50	0.961	1.094	1.054	1.062	0.979	0.981
	(0.0512)	(0.0703)	(0.0373)	(0.0568)	(0.0159)	(0.0433)
Male	1.092***	1.114***	1.064**	1.023	0.985	1.083*
	(0.0257)	(0.0195)	(0.0224)	(0.0137)	(0.0272)	(0.0410)
Male × Over 50	1.033	1.019	1.027	1.034	1.067***	0.938*
	(0.0182)	(0.0162)	(0.0200)	(0.0197)	(0.0203)	(0.0268)
N	12,689,076	4,900,053	1,224,050	2,008,596	1,092,365	908,830

Table A5 reports the odds-ratio coefficient estimates from Eq. (2) where the outcome is whether an individual completed treatment. Black and Hispanic estimates are relative to white. *Over*50 are relative to those under-50.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.10$.

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