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**The role of insurance coverage in outpatient substance use disorder treatment referral, utilization,
and outcomes**

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of
Philosophy at Virginia Commonwealth University

by
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List of abbreviations

2WFE	Two-Way Fixed Effect
AA	Alcoholics Anonymous
ACA	Affordable Care Act
AOR	Adjusted Odd Ratio
AUD	Alcohol Use Disorder
CI	Confidence Interval
DID	Difference In difference
DSM-IV	Diagnostic and Statistical Manual of mental disorders IV
FPL	Federal Poverty Level
IV	Instrumental variable
MAT	Medication- Assisted Treatment
MDE	Major Depression Episode
MOUD	Medications for Opioid Use Disorder
NA	Narcotics Anonymous
NSDUH	National Survey on Drug Use and Health
OD	Opioid Use Disorder
PDMP	Prescription Drug Monitoring Program
RRR	Relative Risk Ratio
SE	Standard Error
SUD	Substance Use Disorder
TEDS-D	Treatment Episode Dataset- Discharge
TOOS	Treatment Obtained in Outpatient Setting

Abstract

The U.S has experienced a high prevalence of substance use disorders, fueled largely by the recent opioid epidemic. Despite many policy efforts to increase the access to and supply of substance use disorder treatment, only 11% of people with a substance use disorder (SUD) access treatment. Among those who received SUD treatment in publicly funded facilities, nearly 70% did not complete it. While treatments obtained in outpatient settings (TOOS), including pharmacological and psychosocial therapies, are considered effective in reducing relapse and recovery outcomes for many substances, the use of total abstinence approaches such as self-help groups are commonplace and oftentimes free, yet have less evidence supporting their effectiveness when used alone compared to TOOS. As most people with SUD are low-income, the lack of stable treatment coverage is a critical barrier to TOOS treatment access and retention, making health insurance a likely key predictor of treatment outcomes. Moreover, Medicaid expansion, which extended health insurance coverage to millions of low-income adults and strengthened the SUD treatment system, should play a significant role in SUD treatment utilization. This study aims to examine correlates of access to and outcomes of outpatient SUD treatment.

Chapter 2: We examined the associations of health insurance coverage and any SUD treatment utilization, as well as the use of TOOS versus the use of self-help only. This study used a non-experimental design that leveraged multiple years of the 2010-2018 National Survey on Drug Use and Health. The final analytic samples of people with any SUD, AUD, and OUD were 42,155, 32,352, and 4,389, respectively. We found that Medicaid insurance coverage was positively associated with any SUD treatment utilization, as well as with the use of TOOS treatment across the any SUD and any OUD populations. Our findings suggested that those who were uninsured tended to use self-help only as a substitute for outpatient medical treatment approaches.

Chapter 3: To investigate the role of Medicaid expansion on referrals to OUD treatment, we used a difference-in-difference (DID) with two-way fixed effect (2WFE) approaches to examine the associations of Medicaid expansion and referral sources, particularly healthcare provider referrals. Eight years of Treatment Episode Data Set- Discharge (TEDS-D) data spanning from 2010 to 2017 were used to explore the associations. Our final analysis sample included 382,609 discharges. The findings indicated that Medicaid expansion was positively associated with the likelihood of being referred by healthcare providers to outpatient treatment for OUD. The findings also suggest that Medicaid expansion has the potential to improve timely and effective access to evidence-based outpatient treatment for OUD via increasing access to healthcare providers.

Chapter 4: Beyond issues of access, treatment retention is a key step toward improving long-term OUD treatment outcomes. Given that Medicaid expansion under the Affordable Care Act (ACA) should play an important role in substance use treatment system improvement, this study used a natural experiment to explore the associations of Medicaid expansion under the ACA with OUD treatment completion and retention in outpatient settings. Similar to study 2, we employed DID with 2WFE to evaluate the effect of Medicaid expansion, using the 2010-2017 TEDS-D data. Our study indicated that Medicaid expansion was positively associated with treatment retention for those who were on medication for OUD, yet negatively associated with treatment completion in outpatient treatment settings. Further research should focus on better understanding the mechanisms by which Medicaid coverage expansions influence treatment retention and completion.

Chapter 1 Introduction

The prevalence of substance use disorders (SUD) is a pressing public health concern in the U.S, with approximately 20 million people suffering from such disorders.¹ According to the Centers for Disease Control and Prevention, more than 70,000 people died in 2017 because of drug overdoses, with opioid overdoses accounting for more than 42,000 deaths.² While costs related to SUD in general are estimated to be approximately 440 billion dollars annually, those associated with opioid use disorder (OUD) in particular have been estimated to reach over \$92 billion (in 2014 U.S dollars).^{3,4}

Substance use disorders have previously been considered acute medical conditions that were addressed through brief treatment episodes aimed at prompting patients to abstain from the substance entirely,⁵ yet relapse rates were high, at more than 80%.⁶ More recent thinking among an increasing number of providers, patients, and medical societies considers SUD a chronic disease,⁷ and the perspective on treatment has changed accordingly. Understanding substance use disorders as a treatable chronic disease has made room for the emergence of approaches that rely more on the health care system to effectively for manage this disease over an extended period of time.⁸

In contrast to treatments obtained in outpatient settings (TOOS), total abstinence approaches remain common. The latter is largely represented by self-help groups, which on their own have less documented evidence-based support for specific substances (e.g., opioids, alcohol), and are associated with high relapse rates and poor recovery outcomes (e.g., health status, quality of life).⁵ TOOS, most notably those that use medications for opioid use disorder (MOUD), have been shown to be an effective intervention in reducing relapse, opioid use-associated transmissions of infectious diseases, and improved recovery outcomes.^{9,10} Even though there is growing attention among policymakers to increase access to SUD treatment, critical gaps remain with only 11% of people with SUD receiving any treatment¹ and only 19% of people with OUD receiving any treatment.¹¹

Barriers to substance treatment utilization include lack of stable financial support to participate and remain in the substance use treatments (e.g., health insurance coverage), limited availability of providers willing to prescribe medication for OUD (MOUD; e.g., methadone, buprenorphine), and stigma toward substance use disorders and treatment.¹² In the U.S, where a significant proportion of those with OUD have lower income (67%),¹¹ lacking health insurance coverage can be a critical barrier. However, little is known about the association between health insurance and substance treatment utilization, and no previous study has examined the role of health insurance in accessing TOOS vs. the use of total abstinence approaches alone. The extent to which individuals with SUD use self-help only groups as a substitute for TOOS when they are uninsured is unknown. Given the importance of evidence based TOOS including pharmacological and psychological therapies for improving SUD recovery outcomes, studies exploring potential determinants of treatment access such as health insurance, are needed.

The question of whether accessed treatment is TOOS is also critically important. Although there remains disagreement about how to define treatment success, treatment completion and treatment retention are generally recognized as key indicators of SUD treatment success.^{13,14} For example, the evidence shows that the better treatment outcomes are achieved when patients with OUD, alcohol use disorder (AUD) stay longer in the treatment,⁷ length of stay in the treatment for OUD, AUD is increasingly recognized as an important indicator for the treatment success.

Among many factors affecting treatment access and outcomes, Medicaid expansion, insurance coverage and provider referral source are important determinants.^{15,16} Medicaid expansion should play a significant role in treatment participation and retention by improving Medicaid insurance coverage. By lowering out-of-pocket payments from patients, health insurance helps patients access long-term medicalized treatment for SUD and other TOOS.^{8,17,18} Additionally, referral sources are key to timely

and effective treatment in healthcare settings, as well as a strong predictor of treatment success.^{19,20}

However, while many studies have explored the role of Medicaid expansion in access to health care in general, far fewer studies have examined the role of insurance coverage in access to care for SUD specifically, and there has been a lack of evidence on importance of coverage on substance treatment outcomes.

To address these crucial gaps, this dissertation focuses on the correlates of access and outcomes of evidence-based treatments for SUD. The long-term purpose of this project is to inform policy efforts to increase access to and improve outcomes of TOOS for SUD in general, and for low-income populations specifically. The study aims are:

Aim 1. To examine associations of health insurance coverage and any SUD treatment utilization as well as TOOS versus self-help only, using 2010-2018 National Surveys on Drug Use and Health (NSDUH)

Hypothesis_{1A}: Having any health insurance is positively associated with access to any SUD treatment.

Hypothesis_{1B}: Those with Medicaid insurance are more likely to access any SUD treatment compared to those who are uninsured.

Hypothesis_{1C}: Individuals with Medicaid insurance are more likely than those who are uninsured to use TOOS whereas those who are uninsured are more likely to use self-help groups only.

Aim 2. To explore associations between Medicaid expansion and referral sources to outpatient treatment for OUD, including healthcare provider referral.

Hypothesis₂: Medicaid expansion increases the likelihood of being referred to outpatient treatment for OUD by healthcare providers in expansion states compared to non-expansion states.

Aim 3

Aim 3.1. To examine associations between Medicaid expansion and OUD treatment completion

Hypothesis_{3.1}: Medicaid expansion increases the likelihood of completing OUD treatment in expansion states compared to non-expansion states.

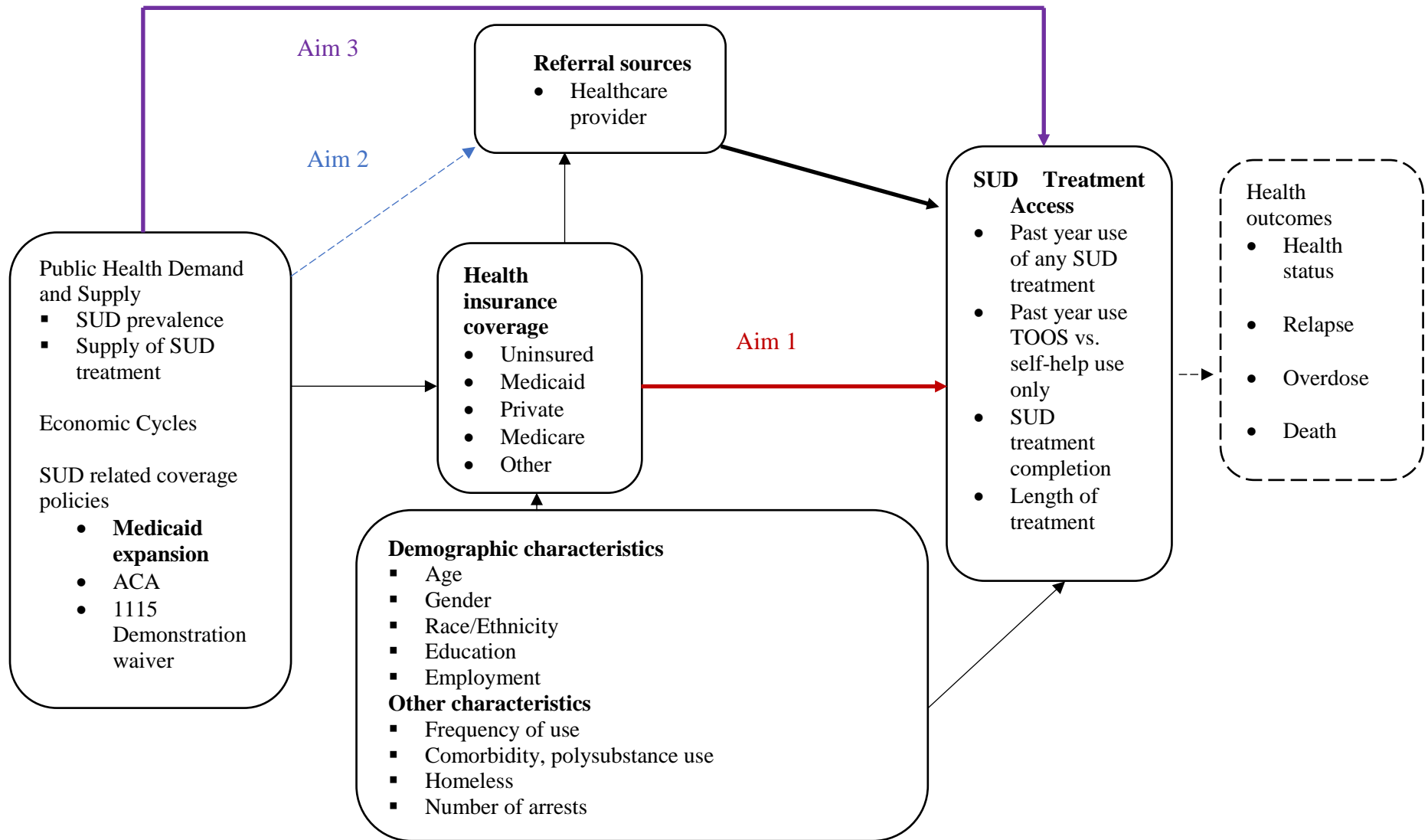
Aim 3.2. To examine associations between Medicaid expansion and OUD patients' length of stay in treatment.

Hypothesis_{3.2}: Medicaid expansion increases the likelihood of longer stay in non-intensive outpatient treatment for OUD in expansion states compared to non-expansion states.

Given the importance of improving access to evidence-based treatments for reducing the public health burden of SUD, studies exploring factors affecting the utilization as well as treatment outcomes of TOOS are needed. Results from study 1 are expected to contribute to our understanding of the role of insurance coverage in SUD treatment utilization patterns, including TOOS. Study 2 explored the role of Medicaid expansion in healthcare provider referral source. The findings are expected to contribute to our understanding of correlate of healthcare provider source, which is considered a key factor in timely, effective SUD treatment access, and may help to inform coverage expansions to ensure substance use treatment access and success. Study 3 explored the role of Medicaid expansion on outpatient treatment for OUD. Studies 2 and 3 contribute to solving the endogeneity of health insurance by using a quasi-experimental difference-in-differences design (DID) to explore the role of Medicaid expansion in both healthcare provider referral source and treatment success.

Overarching Conceptual Model

Figure 1. Detailed conceptual model of Medicaid expansion, health insurance, referral source, and SUD treatment access and outcomes



Background

Figure 1 shows the theoretical associations between factors affecting SUD treatments access as well the treatment outcomes. We applied a modified Donabedian model to describe the associations between structure, process, and outcomes.

Expansions in coverage for SUD treatment

Medicaid has been at the forefront of reforming the delivery system for SUD treatment both indirectly through Affordable Care Act-related expansions in the number of people eligible for Medicaid, and directly via Section 1115 demonstration waivers intended to increase access to SUD treatment. By enabling states to extend Medicaid eligibility to low-income adults, Medicaid expansion has helped increase insurance coverage to many people with SUD. In addition, states are able to apply to the Centers for Medicare and Medicaid Services for the Section 1115 demonstration waivers to allow them to use federal resources to offset costs associated with changing how SUD treatment services are covered and how providers are reimbursed. By lowering the out-of-pocket expenses faced by patients and increasing the supply of SUD treatment providers, such Medicaid policies increase access to SUD treatment among low-income individuals. Previous studies found that Medicaid expansion under the ACA has helped increase coverage among low-income adults with SUD.^{21,22} In addition, Medicaid expansions resulted in substantial increases in the use of evidence-based pharmacological treatment for OUD,²³ including increased availability of medications for OUD including methadone and buprenorphine.²⁴ Specifically, admissions to substance use treatment among Medicaid beneficiaries increased 113% as a result of the expansion without crowding out admissions from individuals with other insurance.²³ Other evidence has demonstrated that ACA-related Medicaid coverage expansions improved rates of SUD treatment utilization among those with OUD.²⁵

Demographic characteristics and SUD treatment access.

Demographic characteristics affecting SUD treatment access include age, gender, race/ethnicity, marital status, educational attainment, and income.^{11,26} Specifically, adolescents, African Americans, and Asian Americans were historically less likely to use opioid treatment.¹¹ Romo and colleagues identified that being older than age 35, not being in the labor force and never having been married were associated with increased odds of receiving SUD treatment while living in a non-metropolitan county, and being in fair/poor health were associated with decreased odds of receiving SUD treatment.²⁶ Furthermore, many studies examined the associations of demographic characteristics across different types of substance use treatment.²⁷⁻²⁹ One study examined gender differences in inpatient, outpatient, and self-help services and found that women tended to use more outpatient treatment services than men.²⁷ For inpatient treatment, African Americans were more likely to delay treatment compared to whites. Another study found that African Americans with heavy drinking or illicit drug use disorders had an increased likelihood of unmet need in substance treatment.²⁸ Prior work suggested that individuals with OUD in rural areas were more likely to have difficulty accessing substance use treatment.²⁹

The relationship between SUD treatment utilization and health outcome

Increasing treatment access, particularly to evidence-based treatment for SUD, is expected to increase health outcomes. This is because evidence-based treatments for SUD are effective in helping patients medically manage their withdrawal symptoms (as is the case with MOUD), allowing them to feel well enough to engage in social and economic activities.^{30,31} For instance, MOUD alone or combined with psychosocial therapies, has been shown to be effective in reducing opioid-related withdrawals and mitigating transmission of infectious diseases associated with opioid use.^{32,33}

The role of health insurance coverage in access to SUD treatment (Study 1).

Not having health insurance is likely a critical barrier to accessing SUD treatment, with insufficient treatment capacity and the stigma of addiction treatment posing additional barriers.^{17,34} By lowering the out-of-pocket costs faced by the consumers, increasing health insurance coverage is expected to improve SUD treatment access, particularly among those with low-incomes. Previous studies on health insurance coverage and service utilization showed a positive correlation between having insurance and SUD treatment access.^{21,25} Beyond the importance of health insurance in accessing any SUD treatment, insurance may relate to access to different types of SUD treatment, specifically whether or not it is TOOS or the only use of self-help. Health insurance, particularly Medicaid, is expected to increase the use of a more evidence-based approach for OUD (e.g., methadone, buprenorphine) over total abstinence approaches such as self-help groups (i.e., Narcotic Anonymous) though no evidence exists to date to support this.

While we did not look at the state characteristics in this study (state identifiers are not available in the public-use version of the NSDUH), we used calendar year to control for year fixed effects, including changes in SUD prevalence across time. Population characteristics including demographic characteristics (e.g., age, gender, race/ethnicity, marital status, education, and income), and needs (e.g., SUD, mental health status) are factors affecting the relationship between coverage and treatment access, and were accounted for in this study.

Medicaid expansion under the ACA and referral sources (Study 2)

Medicaid has been at the forefront of reforming the delivery system for SUD treatment. It plays a significant role in SUD treatment, as it pays for the majority of treatment for individuals with SUD nationwide.³⁵ Similar to other recent SUD treatment policies, Medicaid programs across the country have emphasized the role of TOOS that include pharmacological therapy sometimes combined with psychological therapy.⁸ By enabling states to expand Medicaid eligibility to low-income adults,

Medicaid expansion has helped increase insurance coverage to many people with SUD. Previous studies showed the positive effect of Medicaid expansion on increased health insurance coverages, as well as on the provision and utilization of medication assisted treatment for OUD (e.g., buprenorphine).^{21,24}

Referral source is a key factor in timely and effective treatment as well as a strong predictor of treatment success,^{19,20} likely by influencing access to SUD treatments. For example, previous studies showed positive associations of employer and criminal justice referrals with successful treatment completion, while self-referrals and healthcare referrals were negatively associated with successful completion.¹⁶ However, the recent implementation of SUD facilitated policies that emphasize outpatient treatment should lead to an increasing role of the healthcare referral system in treatment success. In other words, Medicaid expansion is expected to increase referrals to outpatient treatment from healthcare providers, which in turn will increase treatment access, as well as increase treatment success.

The associations of Medicaid expansion and referral sources should also be controlled for individual level characteristics that affect a likelihood of being referred by a specific referral source (e.g., self-referrals, healthcare provider referrals, other institutional referrals, court/criminal referral). These include demographic characteristics (e.g., age, gender, race/ethnicity, education, employment)^{20,36,37} and other characteristics including frequency of opioid use, homeless status, psychiatric comorbidities, and poly substance use.^{20,36,38}

Medicaid expansion under the ACA and SUD treatment (Study 3).

Like other recent SUD treatment policies, Medicaid programs across the country have emphasized the role of outpatient treatment that include pharmacological therapy sometimes combined with psychological therapy.⁸ This emphasis should lead to an increase in the role of the healthcare referral system, which in turn will increase treatment access, as well as treatment success. One previous

study showed that Medicaid expansion had a positive impact on increasing the supply and utilization of medication-assisted treatment (MAT) for OUD.²⁴

Evidence also showed that demographic characteristics including age, gender, race/ethnicity, education attainment, and employment status affected treatment completion and retention.³⁹ Specifically, younger age, male, African Americans were negatively associated with opioid treatment retention.^{39,40} In addition, at least two studies on buprenorphine treatment retention reported that being employed was positively associated with treatment retention.^{40,41} A higher level of education was found to be positively associated with opioid treatment retention.^{42,43} Poly substance use, homelessness, arrests/incarceration, and comorbidities were found to be negatively associated with treatment retention.⁴⁴

The conceptual framework above offers a visual description of our expectations regarding correlates of access to SUD treatment as well as treatment outcomes. This project provides needed insights into the key pathways that are described in the conceptual framework by examining the roles of health insurance coverage, and Medicaid expansion on different types of SUD treatment utilization and outcomes, as well as on healthcare referral source. Specifically, study 1 examined associations of health insurance coverage and SUD treatment utilization, as well as TOOS versus the use of self-help group only. Study 2 examined influence of Medicaid expansion on referral sources, especially healthcare provider referrals. Study 3 explored the role of Medicaid expansion in substance treatment outcomes, including treatment completion and retention.

Chapter 2 Associations between health insurance coverage and outpatient SUD treatment utilization

Abstract

Given the importance of evidence-based treatments for reducing the public health burden of SUD, studies exploring the role of health insurance coverage, particularly Medicaid, in access to different treatment pathways are needed. This study will examine the associations of health insurance coverages with any SUD treatment, as well as the use of Treatment Obtained in Outpatient Setting (TOOS) versus the use of self-help groups alone.

This study used a non-experimental design combining multiple waves of a nationally representative cross-sectional survey. Data from the 2010 to 2018 National Surveys on Drug Use and Health (NSDUH) were used to explore associations between health insurance coverage and any SUD treatment utilization as well as use of evidence-based treatment. The final analytic samples were people aged 18 to 64 with SUD (42,155), AUD (32,352), and OUD (4,389). All analyses used survey weights to be representative of the U.S. population and accounted for the NSDUH's complex survey design. Logistic regressions were used to examine the adjusted associations, controlling for predisposing, enabling characteristics (i.e., health insurance), need (health status and recent major depressive episode), and post Affordable Care Act.

Compared with no insurance, people with Medicaid insurance were more likely to use any past year substance use treatment among those with SUD (AOR 2.1, 95% CI: 1.8-2.4), those with any AUD (AOR 1.9, 95% CI: 1.5-2.3), and those with any OUD (AOR 2.2, 95% CI: 1.6-2.9). For the any SUD and any AUD populations, private health insurance was negatively associated with the past year use of any substance use treatment, compared with no insurance. Compared with no insurance, those with Medicaid insurance were more likely to use TOOS versus self-help only across the any SUD, any AUD, and any OUD populations. For example, for any SUD population, those with Medicaid insurance coverage were

more likely to use TOOS only (vs. self-help only) (AOR 2.0, 95% CI: 1.3-3.0) and any TOOS (vs. self-help only) (AOR 2.1, 95% CI: 1.4-2.9).

In conclusion, this study shows the important role of Medicaid insurance coverage on not only any SUD treatment access but also the use of TOOS approach. The findings also show that those with SUD or OUD who were uninsured tended to use a self-help only approach as the substitute to outpatient medical treatment approach. Intervention programs should target those groups and refer them to evidence-based outpatient treatment.

Introduction

There is a critical gap between the need for and access to SUD treatment in the U.S. According to the National Survey on Drug Use and Health (NSDUH) estimates in 2017, more than 20 million people had substance use disorder (SUD); however, only 11% of people with SUD received any treatment in the past year.¹ With regards to opioids, there were more than 2 million individuals with OUD,¹ yet only 1 in 5 people with OUD received any treatment.¹¹

Lack of health insurance coverage is one of the primary barriers to SUD treatment utilization,¹⁷ others include insufficient treatment capacity³⁴ and stigmatization towards substance use disorders and treatment.⁴⁵ In the U.S where a significant proportion of people with SUD have low income, including 67% of those with OUD,¹¹ lack of health insurance coverage is a significant problem.¹⁸ By lowering the out of pocket payment faced by patients, increasing health insurance coverage is expected to improve the receipt of any SUD treatment, particularly for those with low-income.¹⁷

There are few studies examining the role of health insurance in SUD treatment access in general and OUD treatment access in particular. What we do know from the studies that exist is that improving insurance coverage, as a result of Medicaid expansion under the Affordable Care Act (ACA), increases SUD treatment utilization.^{21,25} Wen and co-authors found that Medicaid expansion improved access to behavioral health care among low-income individuals with SUD.²¹ McKenna's study more specifically suggests that the ACA improved rates of SUD treatment utilization among those with OUD.²⁵ Further, one study pointed out that a 5% increase in private insurance was associated with a 7% increase in the probability of receiving medication for SUD, whereas 5% increase in Medicaid was associated with a 9% increase in the probability of receiving medication for SUD.⁴⁶

There have been various treatments for SUD, including total abstinence-based approaches (e.g., the sole use of self-help groups) and Treatments Obtained in Outpatient Settings (TOOS) approaches. The total abstinence approach, which is largely represented by the use of self-help groups only has been the most commonly used treatment in the U.S.^{5,11,47} Self-help groups, including Alcohol Anonymous, Narcotics Anonymous, and other 12 step programs, are intended to help individuals with SUD to abstain from drugs and alcohol.⁵ This type of treatment is normally free of charge and widely available in the U.S.⁵ However, dropout and nonattendance rates from the sole use of this approach are high.⁶ Humphreys and colleagues pointed out that approximately half of former substance use treatment patients had not attended a single 12-step meeting three months after discharge from an inpatient stay.⁴⁸

However, the evidence on the effectiveness of this approach when combined with TOOS is more positive.^{5,48,49} TOOS, particularly those that use medication for OUD (MOUD; e.g., methadone, buprenorphine, and naltrexone) have been shown to be an effective intervention³² by increasing abstinence from illegal opioids and improving other recovery outcomes.^{9,10,50} The literature suggests TOOS approaches effectively reduce heavy drinking and opioid withdrawal symptoms while increasing treatment retention,⁵¹ and are related to significant declines in overall healthcare costs.⁵² However, one significant barrier to the access of these evidence-based treatments can be their costs to patients.^{53,54} Notably, a prior study showed that lack of insurance posed financial barriers to MOUD access such as buprenorphine treatment.^{55,56}

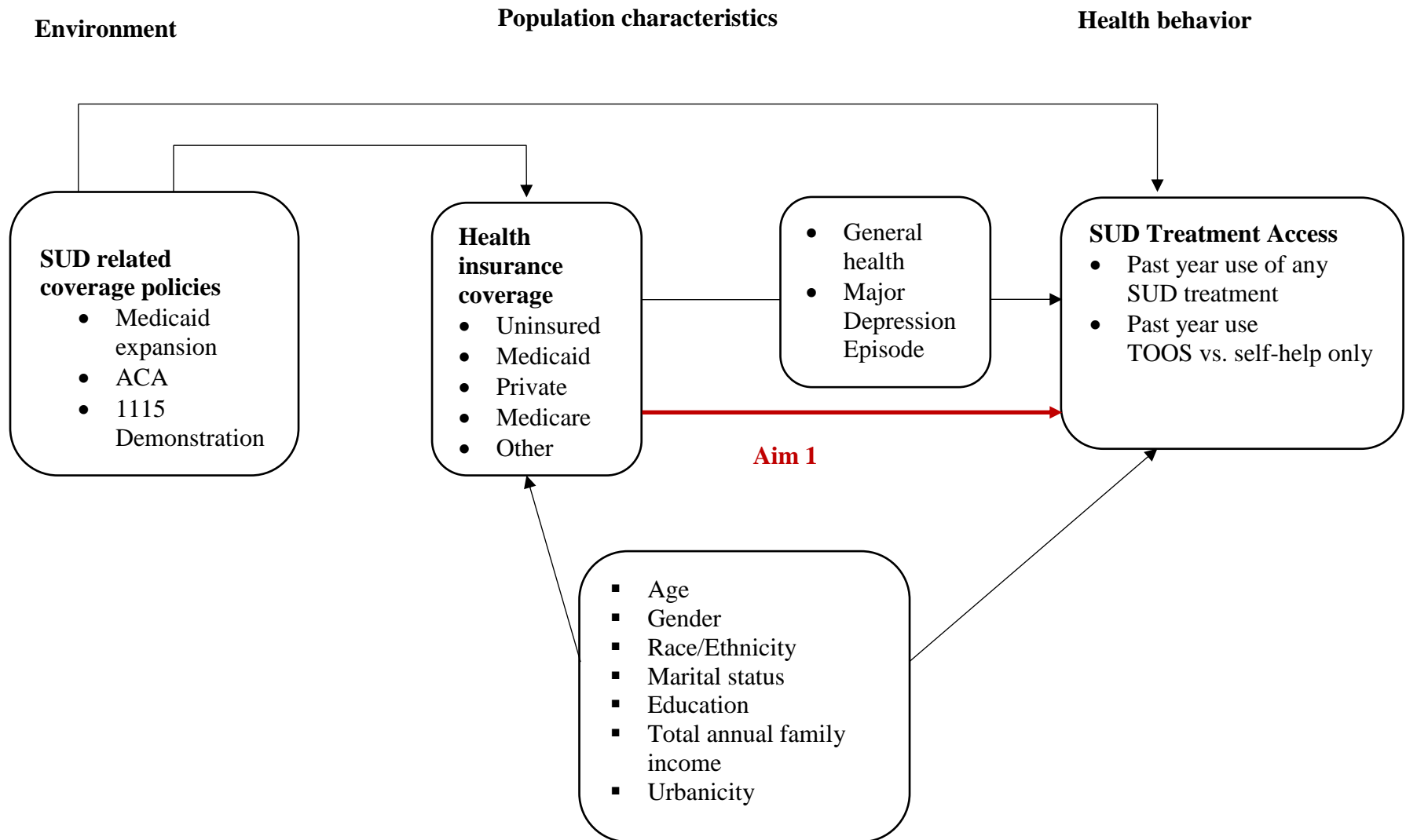
Studies on health insurance and the utilization of different types of treatments, particularly self-help groups and TOOS approaches, remain limited. One study pointed out a significant inverse association between health insurance and non-medical sector use of self-help. Uninsured individuals had a higher likelihood of receiving services from self-help groups than those with private insurance.⁵⁷ However, this study is limited among uninsured young adults aged 18 to 34 years old and was based on

the 1999 National Household Survey on Drug Abuse. Other evidence shows that among buprenorphine patients, sobriety over time was correlated with having private insurance coverage and whether patients attended self-help meetings.⁵⁸ While there has been evidence of effectiveness in the use of pharmacological therapy for OUD, such as methadone, patients using pharmacotherapy have reported not feeling welcome at traditional self-help groups that are designed to achieve total abstinence from narcotics and other drugs due to the fact that peers in self-help groups perceived methadone as continued narcotic use.⁵⁹

Given the importance of evidence-based treatments for reducing the public health burden of SUD, studies exploring the role of health insurance coverage, particularly Medicaid, in access to different treatment pathways are needed.

Conceptual model

Figure 2. Health insurance and utilization of any past year substance use treatment as well as TOOS versus self-help approaches among any SUD/AUD/ODUD populations



This study's theoretical framework was adapted from Andersen's healthcare utilization model.⁶⁰ This framework describes correlations of environment factors, population characteristics and health behaviors, and severity (e.g., comorbid SUD) that affect receipt of health services, particularly for vulnerable populations such as substance users.^{61,62} "Environment factors", which include substance-use-related coverage policies (e.g., Medicaid expansion, 1115 Demonstration Waivers) increase "enabling resources" by increasing who is covered, what SUD treatment services are covered, and how much of these services is covered.^{21,22,24} As Medicaid programs are "means-tested programs", many "predisposing characteristics" including age, gender, marital status, and income, can determine eligibility for public coverage as an enabling resource.^{11,26} Enabling resources in general and health insurance specifically, influence health behaviors, namely increasing utilization of any SUD treatment as well as whether that treatment primarily relies on TOOS versus self-help only.

This study examined the associations of health insurance coverages with any SUD treatment, as well as the use of TOOS treatment versus the use of self-help groups alone. Given that a majority of people with SUD are low-income, public insurance like Medicaid insurance under ACA implementation should play an important role. This study was particularly looking at the role of Medicaid insurance in the use of TOOS versus self-help only.

Hypotheses

H₁: Those with Medicaid insurance will be more likely to access any SUD treatment compared to those who are uninsured

H₂: Individuals with Medicaid insurance will be more likely than those who are uninsured to use TOOS, whereas those who are uninsured will be more likely to use self-help groups only.

The study is expected to contribute to the understanding of those factors that affect the utilization of SUD treatments, including self-help versus outpatient treatment. Findings on health insurance

associated with the use of outpatient treatment compared to the use of self-help only may suggest ways to target certain types of patients, for example, those who are uninsured and only used self-help for referral to evidence-based medication assisted treatment.

Methods

Overview of design and data

This study used a non-experimental design combining multiple waves of a nationally representative cross-sectional survey. Data from the 2010 to 2018 National Surveys on Drug Use and Health (NSDUH) were used to explore associations between health insurance coverage and any SUD treatment utilization as well as the use of evidence-based treatment. The NSDUH is a major source of national estimates of SUD and treatment use among civilian, non-institutionalized persons aged ≥ 12 .⁶³ It has richly detailed data on substance use and mental health that enabled us to include several measurements of SUD diagnosis, treatment, and health insurance coverage, as well as an extensive set of controls for predisposing characteristics (e.g., age, gender, race/ethnicity).

NSDUH included approximately 500,000 persons aged ≥ 12 from 2010 to 2018 (i.e., roughly 55,000-58,000 respondents per year) who are residents of households and non-institutionalized from 50 states and the District of Columbia. We restricted our analysis to people aged 18 to 64 years old (N=338,811) to focus on working-age adults, who are most likely to be uninsured. Using multiple waves of NSDUH data allows for a large sample size to increase statistical power to detect differences among otherwise rare events and populations (e.g., detecting differences in OUD treatment across insurance status). The average survey response rate for the nine years of NSDUH data included in this study was 72%.

Sample

SUD population. Respondents who self-reported either alcohol or any type of illegal drug use in the past year were first defined as substance users in the NSDUH. These respondents were then assessed on abuse and dependence symptoms based on the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria.⁶⁴ The classification of substance abuse was based on an affirmative response to one of four questions which were derived from the DSM-IV criteria. Classification of dependence on a substance was based on a positive response to three out of seven questions matching criteria from the DSM-IV. Respondents were defined as having a SUD if they were defined as having substance abuse or dependence. The final analytic sample of people with SUD aged 18 to 64 years old was 42,155 individuals.

AUD population. Respondents who used alcohol in the past year were assessed on dependence and abuse following the DSM-IV criteria. Alcohol dependence or abuse is defined as alcohol use disorder (AUD). The final analytic sample of people with AUD aged 18 to 64 years old was 32,352 individuals.

ODU population. Respondents who self-reported any non-medical prescription opioid use or heroin use during the past year were first defined as opioid users. There have been changes in the questions and methods asking about prescription opioid use in NSDUH beginning in 2015. From 2010 to 2014, non-medical prescription opioid use was defined as the use of prescription pain relievers in the NSDUH. Since 2015, non-medical prescription opioid use was defined as the use that was "not directed by a doctor".⁶⁵ Respondents, who reported either non-medical opioid use or heroin use in the past year, were assessed for either abuse or dependence symptoms, based on DSM-IV criteria. The classification of opioid abuse was based on an affirmative response to one of four questions derived from the DSM-IV criteria. Classification of opioid dependence was based on an affirmative response to three out of seven questions matching criteria from the DSM-IV. Respondents were defined as having prescription opioid

use disorders if they were defined either having prescription abuse or dependence. Respondents were defined as having heroin use disorder (HUD) if they were defined as either having heroin abuse or dependence. Both prescription OUD and HUD were combined into a more comprehensive OUD category. Even though there has been no change in the questions defining abuse or dependence throughout the study years 2010-2018, questions on screening prescription opioid use and misuse did change (though both indicate the use of prescription not for medical purposes). We conducted a sensitivity analysis that examined several measures related to OUD including past 12- month prescription opioid abuse or dependence, and past 12- month heroin abuse or dependence (Findings were presented in the sensitivity analysis result). Importantly, categorizations of OUD or SUD indicate the need for treatment.^{11,64} The final analytic sample of people with OUD aged 18 to 64 years old was 4,389 individuals.

Measures

SUD treatment utilization (health behaviors)

Any SUD treatment utilization. NSDUH respondents who used alcohol or illicit drugs in their lifetime were asked whether they received any substance use treatment, which refers to treatment or counseling for alcohol, drug use, or medical problems associated with the use of alcohol or illicit drugs. Those who reported that they received treatment in their lifetime were asked whether they received treatment in the past 12 months, with the question " During the past 12 months, that is since [DATE FILL] have you received treatment or counseling for your use of alcohol or any drug, not counting cigarettes?".⁶⁵ The any SUD treatment variable was an indicator for the receipt of any treatment or counseling substance use during the past 12 months. The variable received the value of 1 if respondents used any SUD treatments (including TOOS, self-help groups) and 0 otherwise.

Any OUD treatment utilization. Any opioid treatment was defined as the receipt of treatment or counseling for the respondent's use of prescription opioids or heroin in the past 12 months. The self-reported opioid treatment utilization variable had been used by Wu and co-authors in their study of treatment utilization among people with OUD in the U.S.¹¹

Use of TOOS treatment for SUD. The second set of study outcomes focused on the type of SUD treatment specifying whether that treatment was self-help or TOOS to treat SUD, such as MOUD. NSDUH collected information on treatment in specific facilities including hospital, rehabilitation facilities, mental health centers, emergency rooms, private doctor's offices, prisons or jails, or self-help groups. Self-help treatment was defined as any past year use of self-help groups (e.g., Alcoholics Anonymous (AA) or Narcotics Anonymous (NA)) to treat SUD.⁶⁵ TOOS to treat SUD was defined as past year use of outpatient rehabilitation center, mental health center, or private doctor's office. We constructed binary variables for (1) TOOS only versus self-help only, and (2) any TOOS versus self-help only. The first variable had the value of 1 if respondents used TOOS and did not use self-help in the past year, and 0 if they only used self-help without the use of TOOS; those who used both were not included. The second variable had the value of 1 if respondents used any TOOS (i.e., the only use of TOOS, both TOOS and self-help), and 0 if respondents used self-help only (no TOOS).

Health insurance (enabling resources)

The primary regressors of interest are types of current health insurance coverage. NSDUH allows health insurance to be categorized into 5 types - no insurance, Medicare, Medicaid, private insurance, and other insurance. With regard to dual-eligibles (i.e., those with more than one type of insurance), we used the insurance type that was considered to be the first payer. For example, those covered by Medicare and Medicaid were assigned to Medicare.

Post ACA

While survey *years* could pick up coverage expansion policies including the implementation of the ACA since 2014, we chose post ACA as a covariate variable because of the roles of ACA implementation in increasing insurance coverage⁶⁶ and affecting substance use treatment through defining SUD as one of ten essential health benefits.⁶⁷ The post ACA variable receives the value of 1 if the years were from 2015 to 2018, and 0 if the years were from 2010 to 2014.

Covariates (predisposing characteristics and needs)

Associations of health insurance and utilization of SUD treatment were controlled for *education* (1 if high school graduate and 0 if less than high school), *total family income* (less than \$50,000; \$50,000-\$75,000, and more than \$75,000), and other sociodemographic variables including *age* (18-25, 26-34, 35-49, 50-64), *race/ethnicity* (non-Hispanic White, non-Hispanic African American, Hispanic, Asian and other), *gender* (male and female), and *urbanicity* (large metropolitan, small metropolitan, and non-metropolitan). Education and income were included in the model as they were socioeconomic status affecting both if treatment received and the type of treatment received.^{26,68} Urbanicity or living area was included because it associated with the use of substance treatment utilization.²⁶

The associations were controlled for general *health* (good health, poor health) and mental health status. Past year *major depressive episode (MDE)* was one psychological factor that was included in the conceptual models as a “need” construct that predicts SUD treatment utilization. MDE was a correlate of treatment use given the association between major depression and non-medical opioid use.⁶⁹ Assessment of MDE from NSDUH is based on DSM-IV criteria. MDE is defined if participants experienced either depressed mood, loss of interest, and four symptoms including sleep, eating problems, concentration, and recurrent thought of suicide for a period of two weeks or more.

Statistical analysis

All analyses used survey weights to be representative of the U.S. population, and accounted for the NSDUH's complex survey design. Unadjusted associations between SUD treatment and insurance status were examined using statistical Z tests. Logistic regressions were used to examine the adjusted associations between these measures controlling for predisposing characteristics (age, race/ethnicity, education, income, urbanicity), enabling characteristics (health insurance), need (health status and recent MDE), and post ACA.

Specifically, the following regression model was used to fit to the data:

$$Y_i = \beta_0 + \beta_1 insurance_i + \beta_2 age_i + \beta_3 gender_i + \beta_4 race_i + \beta_5 education_i + \beta_6 income_i + \beta_7 urbanicity_i + \beta_8 health_i + \beta_9 MDE_i + \beta_{10} postACA_t + \varepsilon_i(1)$$

Y_i are the outcomes of interest including any SUD treatment, TOOS only vs. self-help only, any TOOS vs. self-help only. The independent variable of interest is *insurance*. The covariates include *age*, *gender*, *race*, *urbanicity*, *income*, *health*, *MDE*. Logistic regressions were used to examine the adjusted associations between health insurance types and SUD treatment utilization. First, we looked at the adjusted associations between insurance types and any substance use treatment in the past year. Next, we restricted to those who used any substance treatment in the past year and examined the adjusted associations between insurance types and any/only TOOS approach (vs. self-help only).

Sensitivity analysis

In order to take into account variations in ACA implementation effects on different types of health insurance coverage, we ran a sensitivity analysis replacing the covariate *post ACA* by interactions between the post ACA and types of health insurance coverage. This interaction tested whether the ACA implementation moderated the associations between types of insurance coverage and substance use

treatment utilization. For specific types of insurance coverage, the associations between insurance and substance use treatment are moderated by the ACA-related policy changes (e.g., Medicaid expansion, essential health benefits for private insurance).

Importantly, type of insurance might be a function of unobserved health status, leading to endogeneity bias.^{70,71} This means, for example, that we do not know whether people who anticipate poor health purchase more insurance or whether the increased quantity of SUD services observed is because insurance lowers the cost of healthcare for patients. A previous study showed that the magnitude of the insurance effect on the utilization of healthcare is bigger when the endogeneity of insurance status was considered.⁷⁰ Thus, ignoring endogeneity was expected to underestimate the association of insurance coverage on utilization in my models. In an attempt to resolve this issue, a sensitivity test was performed on the results from the model above by using instrumental variables (IV) and selection models. A few previous studies used an IV approach to handle the endogeneity of health insurance.^{70,71} Meer and Rosen used an individual's self-employment status as an IV of health insurance in exploring the association of coverage with health care utilization. They found a positive and statistically significant effect of insurance on healthcare utilization using the IV model.⁷⁰ We constructed past year self-employment status based on two questions: "Have you been self-employed at any time during the past 12 months?" with possible answers of "Yes or No"; and "How many different employers including yourself, have you had in the past 12 months" with possible answers "One, two, three, four or more". The self-employment variable was binary variable, receiving the value of 1 if the respondents responded "Yes" to the first question on self-employment status any time last year and only had one employer in the past 12 months; and 0 otherwise. We ran the IV model using self-employment as an instrument for health insurance and test the sensitivity of the main results to this alternative specification. Additionally, in order to examine potential selection bias that those who were aware of their poor health status might be

more likely to purchase or enrol in health insurance (or more generous coverage), we restricted our analysis to those who reported they had an alcohol problem or opioid problem for less than a year as we might expect these individuals to be less likely to enroll in coverage to seek treatment. Finally, we also examined the associations among different SUD subgroups (i.e., any substance abuse, substance dependence, alcohol abuse, alcohol dependence, opioid abuse, opioid dependence) to examine the variation in the associations between the coverage and treatment access.

Results

Sample characteristics of people with SUD, any AUD, any OUD

Table 1-2 shows characteristics of the any SUD population (n=42,155) as well as the any AUD (n=32,352) and any OUD (n=4,389) sub-populations. Participants' ages range from 18 to 64 years old. For any SUD population, about 11% received any substance use treatment in the past year. Among those who received treatment, about 58% of them accessed TOOS only (vs. 42% used self-help only), whereas about 80% used any TOOS (vs. 20% used self-help only). Percentages of people with any AUD and any OUD who accessed past year substance use treatment were 9% and 36%, respectively. Among those who used SUD treatment, those using any TOOS for any AUD and any OUD were 76% and 88 %, respectively. Further, 50% of respondents with any AUD used TOOS only, and 67% of any OUD population reported TOOS only treatment utilization.

Most people with SUD (59%) had private insurance, about 15% had Medicaid insurance, while more than 20% were uninsured. A majority of people with SUD were under 35 years old (>50%), male (64%), non-Hispanic White (66%), completed high school or more (86%), had a total annual family income less than \$50,000 (55%), and lived in a large metropolitan area (57%). About 85% of people with SUD reported that they had fair or poor health, and more than 18% suffered from MDE. Similar

with the SUD population, most people with any AUD or any OUD were covered by private insurance, followed by Medicaid, and about one-fifth were uninsured. Also, like those with SUD, a majority of the respondents with any AUD or any OUD were under 35 years old, non-Hispanic White, completed high school or more, had total annual family income less than \$50,000, and lived in a large metropolitan area. Almost three-fourths of people with any OUD reported fair/poor health, and one-third suffered from MDE.

Unadjusted associations between health insurance and substance use treatment utilization

Figure 3 shows unadjusted associations between the type of coverage and any use of substance use treatment in the past year, as well as the utilization of TOOS (vs. self-help only) for the SUD population, any AUD, and any OUD sub-populations. Compared to those who were uninsured, people with Medicaid coverage had a higher percentage of using any substance use treatment in the past year (11.7% vs. 21.6%, $p<0.001$), TOOS only (49.7% vs. 69.4%, $p<0.001$), and any TOOS (74.6% vs. 87.0%, $p<0.001$). Similarly, for any AUD and any OUD sub-populations, people with Medicaid coverage were significantly more likely to report substance use treatment, as well as TOOS approach, whereas people with no insurance were more likely to use self-help only ($p<0.01$).

Substance use treatment utilization and insurance coverage before versus after the ACA

Table 1-3 shows past year substance use treatment and health insurance coverage before and after the ACA among those with SUD, any AUD, and any OUD. After the ACA, the percentages of those who received the substance use treatment significantly increased among those with SUD (10.5% vs. 12.8%, $p<0.001$), and any OUD (30.6% vs. 43.7%, $p<0.001$). The past year utilization of any TOOS (vs. self-help only) after the ACA was significantly higher than before the ACA among the SUD population (77.3% vs. 82.7%, $p<0.01$) and any OUD (84.8% vs. 90.5%, $p<0.05$). For the past year utilization of TOOS only (vs. self-help only), there was also a significant increase in the percentages of

those receiving treatment among SUD and any AUD populations. After the ACA, the percentages of people with no insurance decreased ($p < 0.001$), with significant increases in coverage by Medicaid, as well as private insurance (except for any OUD sub-population).

Adjusted associations between health insurance and substance use treatment utilization

Table 1-4 shows the adjusted associations of SUD treatment utilization and health insurance coverage among those with SUD, any AUD, and any OUD. The associations were adjusted for age, gender, race/ethnicity, education, income, urbanicity, general health, mental health and post ACA. Compared with no insurance, people with Medicaid insurance were more likely to use any past year substance use treatment among those with SUD (AOR 2.1, 95% CI: 1.8-2.4), those with any AUD (AOR 1.9, 95% CI: 1.5-2.3), and those with any OUD (AOR 2.2, 95% CI: 1.6-2.9). For any SUD and any AUD populations, private health insurance was negatively associated with the past year use of any substance use treatment, compared with no insurance.

Table 1-5 shows the adjusted associations of the health insurance coverage and utilization of TOOS approach (versus self-help only). Compared with no insurance, those with Medicaid insurance were more likely to use TOOS versus self-help only across the any SUD, any AUD, and any OUD populations. For example, for any SUD population, those with Medicaid insurance coverage were more likely to use TOOS only (vs. self-help only) (AOR 2.0, 95% CI: 1.3-3.0) and any TOOS (vs. self-help only) (AOR 2.1, 95% CI: 1.4-2.9).

Sensitivity analysis results

In order to address the endogeneity of health insurance coverage in the use of SUD treatment, we used an IV model with self-employment status as an instrument. The results show that self-employment was a strong instrument (with F test is greater than 10),⁷² among SUD (F test = 41.8), and AUD

populations (F test = 40.2), but a weak instrument among the OUD population (F test = 0.9). For the SUD population, the IV model showed that those who were insured were more likely to use any SUD treatment during the past year compared with those who were uninsured, and the magnitudes were bigger compared with our main model (AOR 7.4, 95% CI: 1.5-36.9) (Table 1-6). We also saw a larger effect in the IV model comparing TOOS approaches to self-help only; however, it was not statistically significant. For the AUD population, we did not see the significant associations in the IV model between AUD treatment utilization and insurance coverage for any of the outcomes including any SUD treatment, TOOS approach versus self-help approach (Table 1-7).

In order to further examine selection bias, we tested the sensitivity of our adjusted associations by restricting the sample to those who reported that they had an alcohol problem or opioid problem for less than a year. We found that all of the AUD population reported having an alcohol problem for less than a year. For those reporting OUD for less than one year, we found that those with Medicaid were more likely to use any SUD treatment in the past year (AOR 2.3, 95% CI: 1.7-3.2), TOOS only (vs. self-help) (AOR 3.7, 95% CI: 1.5-9.2), any TOOS (vs. self-help) (AOR 2.7, 95% CI: 1.3-5.5). Those with private insurance were also more likely to use any TOOS (vs. self-help) (AOR: 2.7, 95% CI: 1.3-5.5) (Table 1-8).

An alternative adjusted model replacing the covariate post ACA by the interaction of the post ACA and type of health insurance shows that our main findings were robust among those with any SUD and any OUD. Specifically, Medicaid insurance was positively associated with the utilization of any SUD treatment as well as TOOS approach (vs. self-help only) after allowing the Medicaid association with treatment to be moderated by the post ACA policy variable (Appendix Table 1-A1). Additionally, we find a larger magnitude of the odds of receiving TOOS approach (vs. self-help only) among those with OUD and covered by Medicaid insurance, compared to those who were uninsured, when the post

ACA policy variable is included as interaction with coverage type (Appendix Table 1-A2). For example, those with Medicaid insurance were 5.9 times more likely to use any TOOS (vs. self-help only) compared to those who were uninsured, whereas that adjusted odd ratio when controlling for only post ACA was 2.4.

Appendix table 1-B1 to table 1-B6 show the sensitivity analysis results for the associations of health insurance coverages and any SUD treatment as well as TOOS versus self-help only across any substance abuse (Table 1-B1), substance dependence (Table 1-B2), alcohol abuse (Table 1-B3), alcohol dependence (Table 1-B4), opioid abuse (Table 1-B5), and opioid dependence (Table 1-B6). Those with Medicaid insurance were more likely to access any SUD treatment past year across any substance abuse, substance dependence, alcohol abuse, alcohol dependence, and opioid dependence but not among opioid abuse. Among those who used any treatment past year, those with Medicaid coverage were more likely to access the TOOS approach (vs. self-help only) across those with substance dependence, alcohol dependence, and opioid dependence populations. For example, those with opioid dependence and who were covered by Medicaid insurance were more likely to use only TOOS (AOR 2.5, 95% CI: 1.2-5.4), any TOOS (AOR 2.4, 95% CI: 1.3-4.7), compared to those who were uninsured (Table 1-B6).

Another sensitivity analysis was conducted to examine the associations of health insurance types and two different measures of OUD, given that questions on opioid prescription have been changed since 2015. The two different measures of OUD included any pain reliever use disorder and any heroin use disorder. The associations were adjusted for sociodemographic characteristics and post ACA. The sensitivity analysis results show that our main findings were largely robust to the measures of OUD used. Those with any pain reliever disorders as well as those with any heroin use disorder and covered by Medicaid insurance were more likely to use any substance use treatment compared to those who were uninsured (Appendix Table 1-C1). For the adjusted associations of health insurance types and the use of

TOOS approach (vs. self-help only), we also find that those with Medicaid insurance were more likely to use TOOS approach (vs. self-help only) compared with those who were uninsured. On the other hand, we have not found significantly positive associations between Medicaid insurance and the use of the TOOS approach (vs. self-help only) among those with any heroin use disorder (Appendix Table 1-C2).

Discussion

Given that SUD remains a public health concern, studies on the determinants of access to evidence-based outpatient medical treatments such as TOOS are critical. Our study was conducted to understand the role of health insurance coverage, particularly Medicaid insurance, on SUD treatment utilization patterns. We found that those with Medicaid insurance had higher odds of receiving any substance use treatment across any SUD, any AUD, and any OUD populations, compared to those who were uninsured. Those with Medicaid were also more likely to access the TOOS approach, while those who were uninsured were more likely to use self-help approach only. On the other hand, those with private insurance were less likely to use any substance use treatment compared to those who were uninsured, among any SUD or any AUD populations.

Our main findings on the positive association between Medicaid insurance and any past year SUD treatment were consistent with the results from the sensitivity analysis that interacted post ACA and health insurance types, and the sensitivity analysis that restricted to those who had a substance problem for less than a year. Similarly, the main findings on the positive association between Medicaid insurance and utilization of TOOS approaches (vs. self-help) were consistent with the results from the sensitivity analysis that interacted health insurance type and the post ACA indicator among those with SUD or OUD; however, the main findings were not consistent among those with AUD. In addition, for the OUD population, we saw a higher magnitude in the adjusted odd ratios in the sensitivity analysis with interaction term, and the sensitivity analysis among those with opioid problems less than a year,

compared to the main findings. This could be due to the positive effect of the Medicaid insurance expansion under the ACA on the availability of medications for OUD (e.g., buprenorphine) in outpatient settings, which are increasingly being used by Medicaid programs to treat OUD and are considered an effective treatment.^{9,10,24} However, we did not find a significant association among those with AUD. This may be because self-help group approaches, including Alcoholics Anonymous, maybe a preferred form of treatment for those with AUD.

Our study contributes to the literature in several ways. First, our findings aligned with prior work finding the positive association of Medicaid insurance and substance use treatment.^{21,23} Our study population was also similar to previous study populations. A majority of people with substance use disorders were males, non-Hispanic Whites, completed high school or more, low-income, lived in a large metropolitan area, and suffered from psychiatric problems.^{11,26} Compared with before the ACA, there were significantly higher percentages of SUD treatment utilization as well as any TOOS (vs. self-help only) among those with any SUD and any OUD after the ACA implementation. This might be caused by the ACA or other factors including increased awareness of SUD and OUD in states, which requires further research. We also found significant increases in Medicaid insurance coverage among those with any SUD and any OUD after the ACA implementation compared to before the ACA. Importantly, the finding on the positive association of Medicaid insurance and substance use treatment utilization emphasizes the role of Medicaid programs on improving access to substance use treatment. Indeed, Medicaid has been the single largest payer for substance use disorder treatment.⁷³ The important role of Medicaid in the treatment of substance use disorders has increased with the ACA implementation. The ACA defined SUD as one of ten essential health benefits that must be covered and should be covered with parity with other physical health conditions.⁶⁷ Additionally, a growing number of states have implemented the Section 1115 Demonstration waiver for SUD demonstration projects.

The Medicaid expansion under the ACA and the Section 1115 Demonstration waiver have resulted in more Medicaid recipients and greater access to evidence-based treatment options for SUD and OUD.^{25,74} The enhancement of treatment options includes increased medication availability for OUD and integration of care for physical health and SUD.^{67,75,76} The finding on positive role of Medicaid insurance and SUD treatment utilization informs policy makers and Medicaid programs to continue their effort in extending Medicaid insurance coverage to treat SUD.

Beyond the association between health insurance types and any substance use treatment utilization, our study contributes to the understanding of health insurance types and SUD treatment patterns. Specifically, the adjusted associations pointed out that Medicaid insurance was also positively associated with the use of medical outpatient treatments such as TOOS, whereas uninsured people with SUD or OUD were more likely to use self-help only. While self-help groups have been the most commonly used treatment in the U.S.,¹¹ our results also suggest that those with SUD or OUD who were uninsured used self-help only as a potentially lower cost substitute to more evidence-based outpatient treatments. Evidence shows that the effectiveness of self-help approach is more positive when combined with evidence-based outpatient treatments than self-help alone.^{48,58} Our study finding provides a suggestion for intervention programs in general and Medicaid programs in particular to target uninsured people in self-help groups, referring them to more evidence-based outpatient treatments for their SUD, especially OUD.

Our study findings, however, show that those with any SUD or any AUD and who were privately insured had lower odds of receiving any substance use treatment in the past year compared to those who were uninsured. While our study indicated that a majority of people with any SUD, any AUD, or any OUD were covered by private insurance (Table 1-2), our adjusted association results pointed out that private insurance coverage has, to date, played a less significant role in access to substance use treatment

in general, at least when comparing with no insurance, or Medicaid. We suppose this finding is in contrast to previous work highlighting the importance of private insurance in access to SUD medications, especially for OUD treatment such as buprenorphine.⁴⁶ Rather, our study findings suggest that people with private insurance had less severe SUD (Appendix 1-D), and thus, were less likely to get substance use treatment.

Limitations

This study has several limitations. First, the results were based on a cross-sectional NSDUH survey; therefore, we could not draw a causal interpretation. Second, health insurance coverage, substance use history, and utilization of SUD treatment were self-reported. They might be measured with errors. However, NSDUH has a number of strengths for addressing the examined associations including large nationally representative sample, comprehensive, detailed sociodemographic, health, different types of treatment utilization related information. Importantly, NSDUH data was collected using highly private and confidential mode (e.g., computer-assisted self-interviewing) for sensitive topics such as substance use.⁷⁷ Third, type of insurance might be a function of unobserved health status, resulting to endogeneity bias in the estimate of association of health insurance and SUD treatment utilization.^{70,71} A few previous studies used an instrumental variable (IV) approach to handle the endogeneity of health insurance^{70,71} found a positive and statistically significant effect of insurance on healthcare utilization.⁷⁰ When taking into account the endogeneity of insurance status, the magnitude of the insurance effect on the SUD treatment utilization increased. In this regard, our study findings only suggest the direction, but not the possible magnitude of the associations.

Conclusion

This study shows the important role of Medicaid insurance coverage on any SUD treatment access and the use of TOOS approach. Specially, the findings also show that those with SUD or OUD and who were uninsured tended to use the self-help only approach as the substitute to the outpatient

medical treatment approach. This could be an opportunity for intervention programs that typically refer to self-help groups for SUD treatment to shift referrals towards a more evidence-based medical outpatient treatment, particularly for OUD treatment. Further studies should include more detailed measures of treatment supply and other environmental factors that might impede or facilitate SUD treatment access in general and OUD treatment access in particular. For example, further studies should include treatment supply, economic indicators, and substance use prevalence indicators at the state level from the restricted NSDUH dataset. Subsequent studies also should look for additional instrumental variables or other approaches to address the endogeneity of health insurance, to ensure estimates of the association between insurance and treatment outcomes are internally valid and consistent. Our study findings suggest that SUD treatment policies should continue to expand Medicaid insurance coverage to increase access to evidence-based substance use treatment such as outpatient medical treatments TOOS.

Table 1-1. Treatment utilization in specific facilities, NSDUH 2010-2018

Past year treatment utilization in specific facilities	Any SUD N=42,155 Frequency % (SE)	Any AUD N=32,352 Frequency % (SE)	Any OUD N=4,389 Frequency % (SE)
Any treatment past year	4,430 11.3% (0.25)	2867 9.4% (0.27)	1424 35.7% (1.16)
<i>Any self-help</i>	2613 62.6% (1.14)	1699 64.3% (1.42)	938 67.8% (1.84)
<i>Any TOOS</i>	2,828 70.8% (1.11)	1,691 66.4% (1.47)	1,071 81.9% (1.58)
Outpatient rehabilitation center	69.7% (1.44)	66.9% (1.93)	76.3% (2.08)
Mental health center	50.4% (1.50)	50.6% (1.98)	48.1% (2.28)
Private doctor offices	38.8% (1.50)	37.3% (2.00)	46.5% (2.30)
<i>Others treatment services</i>	1991 50.5% (1.24)	1263 51.1% (1.57)	817 63.2% (1.96)
Inpatient rehabilitation center	70.8% (1.57)	69.6% (2.04)	76.8% (2.19)
Inpatient, hospital	62.7% (1.64)	64.7% (2.08)	65.8% (2.41)
Emergency room	44.1% (1.74)	46.2% (2.25)	45.8% (2.59)
Jail/prison	21.5% (1.41)	21.2% (1.81)	20.7% (2.05)
Any TOOS versus self-help only	N=3,523	N=2,195	N=1,239
Any TOOS	2828 79.7% (1.06)	1691 76.0% (1.45)	1071 87.6% (1.41)
TOOS only versus self-help only	N=1,741	N=1,100	N=509
TOOS only	1046 57.5% (1.88)	596 50.1% (2.44)	341 67.2% (3.20)

Table 1-2. Sample characteristics

	Any SUD	Any AUD	Any OUD
Sample size, unweighted	42,155	32,352	4,389
Weighted %	9.7%	7.6%	1.0%
	%(SE)	%(SE)	%(SE)
Any substance use treatment utilization			
Yes	11.3 (0.25)	9.4 (0.27)	35.7 (1.16)
TOOS only vs. Self-help only	N=3,523	N=2,195	N=1,239
TOOS only	57.5 (1.88)	50.1 (2.44)	67.2 (3.20)
Self-help only	42.5 (1.88)	49.9 (2.44)	32.8 (3.20)
Any TOOS vs. Self-help only	N=1,741	N=1,100	N=509
Any TOOS	79.7 (1.06)	76.0 (1.45)	87.6 (1.41)
Self-help only	20.3 (1.06)	24.0 (1.45)	12.4 (1.41)
Health insurance types			
None	21.1 (0.32)	20.4 (0.36)	26.6 (1.06)
Medicaid	14.8 (0.26)	12.1 (0.27)	28.9 (1.06)
Private	58.8 (0.38)	62.2 (0.43)	38.4 (1.12)
Medicare and other insurance	5.3 (0.17)	5.25 (0.19)	6.03 (0.64)
Age in years			
18-25	30.9 (0.29)	28.9 (0.32)	26.9 (0.81)
26-34	25.5 (0.34)	25.4 (0.38)	30.2 (1.07)
35-49	26.0 (0.35)	27.2 (0.40)	24.9 (0.99)
50-64	17.6 (0.40)	18.6 (0.45)	18.0 (1.22)
Sex			
Male	64 (0.36)	64.2 (0.42)	59.7 (1.14)
Race			
Non-Hispanic Whites	66.1 (0.37)	66.4 (0.42)	72.8 (1.10)
Non- Hispanic African Americans	11.7 (0.24)	10.6 (0.26)	9.91 (0.81)
Hispanic	16.1 (0.30)	16.8 (0.35)	12.1 (0.83)
Other race/ethnicity	6.1 (0.17)	6.1 (0.19)	5.2 (0.46)
Education			
High school or more	86.4 (0.27)	86.7 (0.30)	78.6 (0.94)
Total annual family income			
< \$50,000	54.7 (0.39)	52.0 (0.45)	65.4 (1.12)
\$ 50,000-74,999	14.6 (0.27)	15.2 (0.32)	13.4 (0.79)
75,000 or more	30.7 (0.37)	32.8 (0.43)	21.2 (0.99)
Urbanicity			
Large metropolitan	57.1 (0.37)	57.4 (0.43)	53.5 (1.15)
Small metropolitan	30.0 (0.34)	30.0 (0.39)	31.1 (1.05)
Non-metropolitan	12.9 (0.23)	12.7 (0.26)	15.4 (0.78)
Health status			
Good health	14.7 (0.29)	13.4 (0.32)	25.3 (1.08)
Major Depression Episode (MDE)			
Yes	18.2 (0.30)	16.9 (0.33)	28.5 (1.09)

Figure 3. An adjusted association between health insurance coverage and SUD treatment utilization

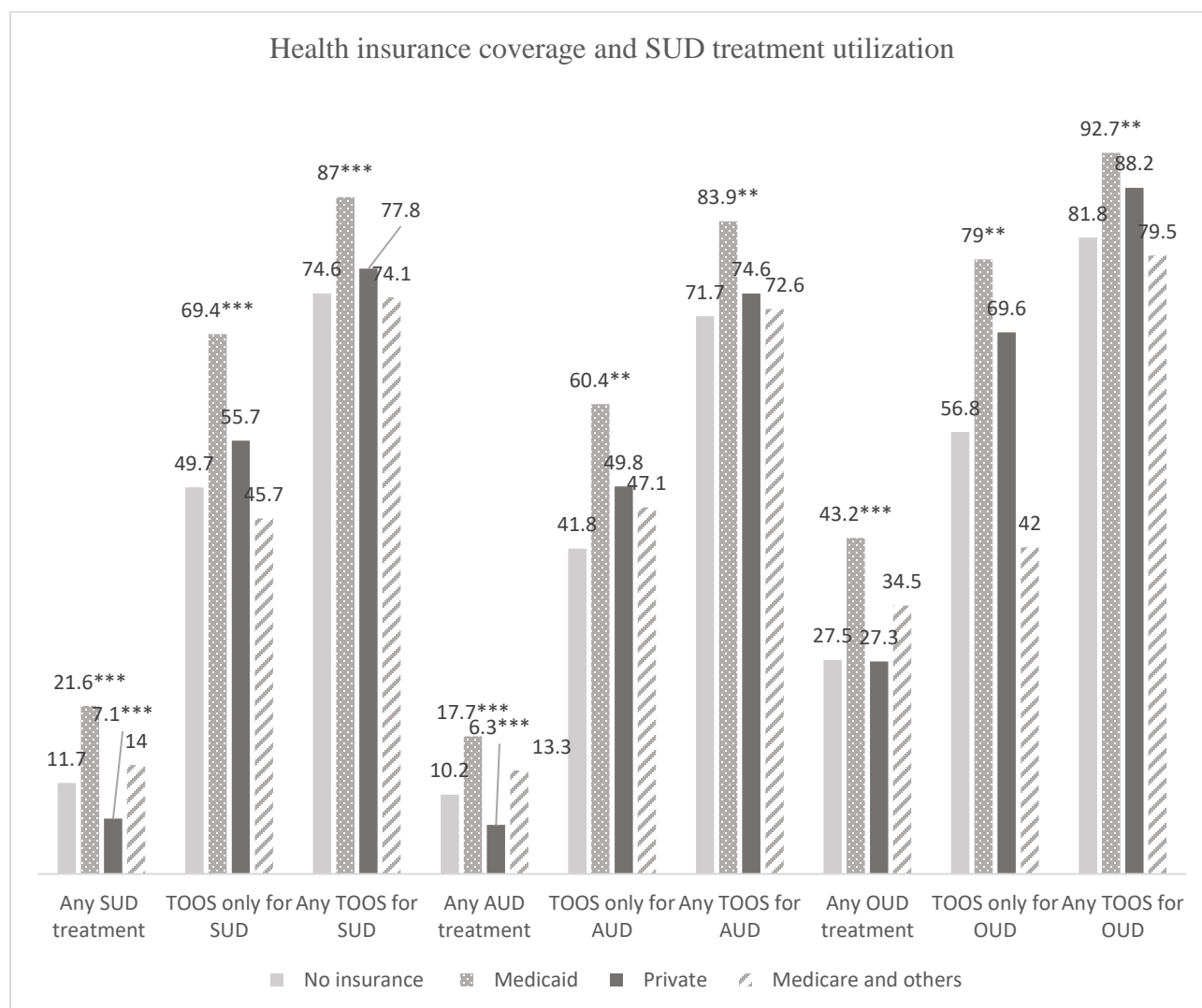


Table 1-3. Treatment utilization and health insurance coverage before and after ACA

	Any SUD		Any AUD		Any OUD	
Sample size	42,155		32,352		4,389	
Population size	169,434,078		133,338,166		17,756,770	
	Pre ACA	Post ACA	Pre ACA	Post ACA	Pre ACA	Post ACA
	% (SD)	% (SD)	% (SD)	% (SD)	% (SD)	% (SD)
Past year treatment						
Yes	10.5 (0.32)	12.8*** (0.35)	9.1 (0.34)	9.9 (0.38)	30.6 (1.49)	43.7*** (1.55)
TOOS only versus self-help only						
TOOS only	53.4 (2.60)	62.8* (2.63)	46.0 (3.06)	56.2* (3.77)	62.5 (4.90)	73.1 (4.06)
Any TOOS versus self-help only						
Any TOOS	77.3 (1.54)	82.7** (1.38)	74.3 (1.99)	78.6 (2.04)	84.8 (2.26)	90.5* (1.63)
Health insurance						
<i>Type of health insurance</i>		p<0.001		p<0.001		p<0.001
No insurance	25.2 (0.47)	15.6 (0.40)	24.5 (0.53)	14.6 (0.45)	31.9 (1.53)	20.3 (1.41)
Medicaid	12.0 (0.33)	18.4 (0.42)	10.0 (0.34)	15.1 (0.46)	23.2 (1.40)	35.8 (1.61)
Private	57.5 (0.53)	60.6 (0.54)	60.3 (0.59)	65.1 (0.62)	38.8 (1.55)	38.0 (1.63)
Medicare and others	5.2 (0.23)	5.5 (0.26)	5.18 (0.26)	5.3 (0.29)	6.2 (0.88)	5.9 (0.93)

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

Table 1-4. Adjusted associations of any treatment utilization past year and different types of health insurance coverage, controlling for sociodemographic characteristics and post ACA.

	Any SUD	Any AUD	Any OUD
Sample size	39,130	30,219	3,897
Population size	154,810,987	123,018,127	15,166,167
	Any SUD treatment past year AOR (95%CI)	Any SUD treatment past year AOR (95%CI)	Any SUD treatment past year AOR (95%CI)
Health insurance			
No insurance = reference			
Medicaid	2.07*** (1.78 - 2.40)	1.87*** (1.54 - 2.27)	2.18*** (1.63 - 2.91)
Private	0.64*** (0.55 - 0.73)	0.71*** (0.60 - 0.85)	1.03 (0.78 - 1.36)
Medicare and others	1.29* (1.03 - 1.61)	1.43** (1.09 - 1.87)	1.55 (0.94 - 2.57)
Age in years			
18-25= reference			
26-34	1.31*** (1.17 - 1.47)	1.18* (1.02 - 1.37)	1.09 (0.87 - 1.36)
35-49	1.51*** (1.35 - 1.70)	1.48*** (1.28 - 1.71)	1.19 (0.93 - 1.54)
50-64	1.49*** (1.22 - 1.81)	1.53*** (1.21 - 1.92)	1.07 (0.69 - 1.66)
Sex			
Female= reference			
Male	1.32*** (1.18 - 1.47)	1.50*** (1.30 - 1.72)	1.22 (0.98 - 1.53)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.67*** (0.57 - 0.79)	0.86 (0.71 - 1.05)	0.75 (0.51 - 1.12)
Hispanic	0.63*** (0.53 - 0.75)	0.72** (0.59 - 0.88)	0.66* (0.47 - 0.95)
Other race/ethnicity	0.75** (0.61 - 0.92)	0.89 (0.71 - 1.13)	0.43*** (0.27 - 0.66)
Education			
High school or less=ref			
High school or more	0.79*** (0.68 - 0.91)	0.71*** (0.59 - 0.85)	1.13 (0.87 - 1.46)
Total annual family income			
< \$50,000= ref			
\$ 50,000-74,999	0.95 (0.81 - 1.11)	0.99 (0.82 - 1.21)	1.01 (0.74 - 1.39)
75,000 or more	0.70***	0.66***	0.71*

	(0.60 - 0.81)	(0.55 - 0.80)	(0.53 - 0.95)
Urbanicity			
Large metropolitan=			
ref			
Small metropolitan	0.99 (0.88 - 1.11)	1.08 (0.93 - 1.24)	0.76* (0.60 - 0.96)
Non-metropolitan	0.95 (0.82 - 1.09)	0.93 (0.78 - 1.12)	0.67** (0.51 - 0.89)
Health status			
Fair/poor= ref			
Good health	0.83* (0.72 - 0.96)	0.80* (0.66 - 0.96)	1.17 (0.89 - 1.53)
Major Depression			
Episode (MDE)			
No= ref			
Yes	2.14*** (1.89 - 2.42)	2.60*** (2.24 - 3.02)	1.51*** (1.18 - 1.92)
Post ACA			
	1.24*** (1.11 - 1.38)	1.14* (1.00 - 1.31)	1.65*** (1.33 - 2.05)

***p<0.001, **p<0.01, *p<0.05. AOR= Adjusted Odd Ratios, CI= Confidence Interval. Ref= Reference

Table 1-5. Adjusted associations of TOOS utilization (versus self-help) and different types of health insurance coverage, controlling for sociodemographic characteristics and post ACA.

	Any SUD		Any AUD		Any OUD	
Sample size	1,696	3,406	1,069	2,125	494	1,191
Population size	6,732,414	14,029,360	4,353,406	9,058,392	1,795,907	4,728,784
	TOOS only	Any TOOS	TOOS only	Any TOOS	TOOS only	Any TOOS
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Health insurance						
No insurance = reference						
Medicaid	1.97** (1.30 - 3.00)	2.05*** (1.44 - 2.92)	1.90* (1.10 - 3.30)	1.86** (1.18 - 2.93)	2.45* (1.18 - 5.10)	2.38** (1.29 - 4.38)
Private	1.16 (0.78 - 1.72)	1.18 (0.84 - 1.65)	1.23 (0.77 - 1.99)	1.15 (0.77 - 1.71)	1.71 (0.79 - 3.73)	2.02 (1.00 - 4.10)
Medicare and others	0.77 (0.41 - 1.46)	0.93 (0.52 - 1.65)	1.04 (0.48 - 2.27)	0.94 (0.48 - 1.86)	0.52 (0.14 - 1.95)	0.84 (0.25 - 2.88)
Age in years						
18-25= reference						
26-34	0.91 (0.63 - 1.29)	1.03 (0.75 - 1.41)	0.81 (0.52 - 1.26)	0.97 (0.66 - 1.42)	1.52 (0.75 - 3.07)	1.71 (0.88 - 3.34)
35-49	0.72 (0.50 - 1.03)	0.85 (0.63 - 1.16)	0.63* (0.40 - 0.99)	0.82 (0.57 - 1.17)	1.41 (0.68 - 2.95)	1.18 (0.60 - 2.32)
50-64	0.86 (0.48 - 1.53)	1.16 (0.71 - 1.89)	0.88 (0.45 - 1.73)	1.29 (0.73 - 2.27)	3.92 (0.85 - 18.00)	5.14* (1.16 - 22.71)
Sex						
Female= reference						
Male	0.67* (0.48 - 0.94)	0.75* (0.56 - 1.00)	0.77 (0.51 - 1.15)	0.79 (0.55 - 1.13)	0.72 (0.40 - 1.28)	0.78 (0.44 - 1.36)
Race						
Non-Hispanic Whites= ref						
Non- Hispanic African Americans	0.99 (0.59 - 1.65)	1.27 (0.83 - 1.95)	1.40 (0.74 - 2.65)	1.61 (0.97 - 2.68)	1.20 (0.38 - 3.78)	2.55 (0.77 - 8.43)
Hispanic	0.74 (0.46 - 1.19)	0.81 (0.55 - 1.18)	0.94 (0.53 - 1.65)	0.89 (0.56 - 1.40)	0.72 (0.28 - 1.82)	1.09 (0.48 - 2.44)
Other race/ethnicity	0.77 (0.41 - 1.46)	0.83 (0.49 - 1.40)	1.38 (0.68 - 2.81)	1.29 (0.73 - 2.30)	1.13 (0.35 - 3.68)	1.08 (0.42 - 2.77)

EducationHigh school or
less=ref

High school or more	1.10 (0.76 - 1.61)	0.92 (0.67 - 1.27)	1.19 (0.72 - 1.95)	0.86 (0.58 - 1.29)	1.06 (0.52 - 2.17)	0.79 (0.41 - 1.54)
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**Total annual family
income**

< \$50,000= ref

\$ 50,000-74,999	1.11 (0.69 - 1.77)	1.12 (0.73 - 1.71)	1.35 (0.78 - 2.33)	1.16 (0.71 - 1.90)	1.33 (0.62 - 2.87)	1.30 (0.62 - 2.73)
75,000 or more	1.53 (1.00 - 2.36)	1.25 (0.87 - 1.79)	1.68 (1.00 - 2.84)	1.24 (0.82 - 1.89)	1.54 (0.66 - 3.60)	1.56 (0.76 - 3.21)

UrbanicityLarge metropolitan=
ref

Small metropolitan	1.25 (0.89 - 1.75)	1.05 (0.79 - 1.41)	1.33 (0.88 - 2.01)	1.04 (0.74 - 1.48)	1.58 (0.80 - 3.12)	1.41 (0.75 - 2.63)
Non-metropolitan	1.41 (0.94 - 2.13)	1.15 (0.82 - 1.62)	1.72* (1.02 - 2.90)	1.29 (0.85 - 1.97)	1.80 (0.89 - 3.64)	1.48 (0.80 - 2.73)

Health status

Fair/poor= ref

Good health	0.59** (0.39 - 0.87)	0.76 (0.53 - 1.09)	0.54* (0.32 - 0.90)	0.76 (0.50 - 1.16)	0.96 (0.47 - 1.95)	1.09 (0.55 - 2.14)
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**Major Depression
Episode (MDE)**

No= ref

Yes	0.93 (0.66 - 1.30)	1.31 (0.97 - 1.78)	0.73 (0.49 - 1.08)	1.17 (0.83 - 1.66)	1.05 (0.55 - 1.99)	1.49 (0.84 - 2.64)
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Post ACA

	1.35 (0.99 - 1.85)	1.23 (0.94 - 1.61)	1.42 (0.96 - 2.11)	1.17 (0.84 - 1.63)	1.04 (0.58 - 1.89)	1.20 (0.73 - 1.99)
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***p<0.001, **p<0.01, *p<0.05

AOR= Adjusted Odd Ratios, CI= Confidence Interval. Ref= Reference

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-6. IV models for associations between health insurance coverage and any SUD treatment utilization as well as TOOS versus self-help approaches: SUD population

	Any SUD treatment	Any SUD treatment- IV model	TOOS only vs. self -help only	TOOS only vs. self- help only - IV model	Any TOOS vs. self-help only	Any TOOS vs. self-help only- IV model
N	39,130	34,063	2,956	2,291	5,619	4,287
	AOR	AOR	AOR	AOR	AOR	AOR
	95%CI	95%CI	95%CI	95%CI	95%CI	95%CI
Insured	1.05	7.37*	1.52**	5.79	1.40**	10.06
	(0.92 - 1.20)	(1.47 - 36.94)	(1.16 - 1.98)	(0.35 - 96.13)	(1.11 - 1.77)	(0.97 - 104.42)
Residual1		0.12*				
		(0.02 - 0.63)				
Residual 2				0.22		
				(0.01 - 3.66)		
Residual 3						0.12
						(0.01 - 1.29)
Age in years						
18-25=						
reference						
26-34	1.42***	1.60***	1	0.94	1.03	0.98
	(1.27 - 1.60)	(1.32 - 1.93)	(0.77 - 1.31)	(0.69 - 1.30)	(0.81 - 1.30)	(0.74 - 1.29)
35-49	1.60***	1.58***	0.73*	0.72*	0.83	0.83
	(1.42 - 1.80)	(1.37 - 1.83)	(0.57 - 0.95)	(0.53 - 0.98)	(0.67 - 1.04)	(0.64 - 1.07)
50-64	1.58***	1.31*	0.57**	0.53*	0.72*	0.65*
	(1.31 - 1.91)	(1.01 - 1.69)	(0.39 - 0.84)	(0.32 - 0.89)	(0.53 - 0.99)	(0.43 - 0.97)
Sex						
Female=						
reference						
	1.22***	1.53***	0.79	1.08	0.83	1.09
	(1.10 - 1.36)	(1.27 - 1.85)	(0.62 - 1.02)	(0.77 - 1.52)	(0.67 - 1.04)	(0.83 - 1.44)
Total annual family income						
<						
\$50,000= ref						
\$ 50,000-	0.73***	0.57***	1.06	0.96	0.96	0.82
74,999	(0.63 - 0.86)	(0.43 - 0.76)	(0.75 - 1.51)	(0.53 - 1.72)	(0.71 - 1.32)	(0.49 - 1.35)

\$75,000 or more	0.50*** (0.43 - 0.58)	0.37*** (0.26 - 0.52)	1.18 (0.85 - 1.65)	0.98 (0.47 - 2.04)	0.94 (0.71 - 1.24)	0.64 (0.36 - 1.16)
Race/ethnicity						
Non-Hispanic Whites= ref						
Non-Hispanic African Americans	0.80** (0.68 - 0.93)	0.79* (0.63 - 0.98)	1.17 (0.78 - 1.74)	1.31 (0.80 - 2.15)	1.44* (1.03 - 2.00)	1.48* (1.00 - 2.20)
Hispanics	0.69*** (0.58 - 0.81)	0.8 (0.61 - 1.05)	0.76 (0.53 - 1.08)	0.89 (0.52 - 1.52)	0.88 (0.66 - 1.18)	1.14 (0.74 - 1.78)
Other race/ethnicity	0.82 (0.68 - 1.01)	0.73** (0.59 - 0.92)	1.04 (0.64 - 1.68)	1.16 (0.67 - 2.00)	1.15 (0.77 - 1.72)	1.12 (0.72 - 1.72)
Education						
High school or less= ref						
High school or more	0.67*** (0.58 - 0.77)	0.45*** (0.32 - 0.63)	1.03 (0.77 - 1.36)	0.87 (0.51 - 1.50)	0.99 (0.78 - 1.27)	0.7 (0.44 - 1.11)
Urbanicity						
large metropolitan = ref						
Small metropolitan	1.01 (0.90 - 1.13)	1.02 (0.90 - 1.16)	1.19 (0.92 - 1.54)	1.24 (0.93 - 1.66)	0.99 (0.80 - 1.24)	1.02 (0.80 - 1.31)
Non-metropolitan	0.99 (0.86 - 1.14)	1.1 (0.94 - 1.30)	1.41* (1.00 - 1.98)	1.79** (1.20 - 2.68)	1.12 (0.83 - 1.51)	1.43* (1.01 - 2.03)
Health status						
Fair/poor = ref						
Good health	0.70*** (0.60 - 0.80)	0.63*** (0.52 - 0.76)	0.48*** (0.35 - 0.66)	0.49*** (0.32 - 0.75)	0.60*** (0.45 - 0.79)	0.58** (0.40 - 0.82)
MDE						
No=ref						

Yes	2.19*** (1.94 - 2.47)	2.26*** (1.97 - 2.60)	1.05 (0.79 - 1.39)	1.03 (0.74 - 1.45)	1.47** (1.14 - 1.90)	1.43* (1.08 - 1.91)
Post ACA	1.31*** (1.18 - 1.45)	1.1 (0.93 - 1.30)	1.37* (1.08 - 1.76)	1.24 (0.86 - 1.80)	1.30* (1.06 - 1.60)	1.18 (0.89 - 1.57)

Adjusted Wald test (instrumental test) found that self-employment variable was strong with F = 41.77 (p<0.001)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval. Ref= Reference

Table 1-7. IV models for associations between health insurance coverage and any SUD treatment utilization as well as TOOS versus self-help approaches: AUD population.

	Any AUD treatment	Any AUD treatment- IV model	TOOS only vs. self-help only	TOOS only vs. self-help only - IV model	Any TOOS vs. self-help only	Any TOOS vs. self-help only- IV model
N	30,219	26,899	1,069	867	2,125	1,693
	AOR	AOR	AOR	AOR	AOR	AOR
	95%CI	95%CI	95%CI	95%CI	95%CI	95%CI
Insured	1.05 (0.89 - 1.23)	5.94 (0.92 - 38.48)	1.41 (0.93 - 2.15)	28.60 (0.21 - 3,948.78)	1.31 (0.92 - 1.89)	14.87 (0.28 - 778.29)
Residual 1		0.16 (0.02 - 1.07)				
Residual 2				0.05 (0.00 - 6.31)		
Residual 3						0.09 (0.00 - 4.84)
Age in years						
18-25=						
reference						
26-34	1.25** (1.08 - 1.45)	1.37** (1.10 - 1.72)	0.87 (0.56 - 1.34)	0.94 (0.50 - 1.77)	1.02 (0.70 - 1.48)	0.98 (0.58 - 1.66)
35-49	1.54*** (1.33 - 1.78)	1.52*** (1.27 - 1.81)	0.67 (0.43 - 1.05)	0.75 (0.43 - 1.29)	0.86 (0.60 - 1.23)	0.95 (0.63 - 1.43)
50-64	1.61*** (1.29 - 2.02)	1.41* (1.05 - 1.89)	0.89 (0.45 - 1.75)	0.88 (0.35 - 2.18)	1.33 (0.76 - 2.35)	1.23 (0.57 - 2.64)
Sex						
Female=						
reference						
	1.42*** (1.24 - 1.63)	1.79*** (1.44 - 2.22)	0.74 (0.50 - 1.11)	0.98 (0.54 - 1.78)	0.75 (0.53 - 1.08)	0.87 (0.52 - 1.43)
Total annual family income						
<						
\$50,000= ref						
\$ 50,000-74,999	0.81* (0.67 - 0.98)	0.62** (0.44 - 0.88)	1.26 (0.73 - 2.18)	0.95 (0.37 - 2.49)	1.07 (0.65 - 1.75)	0.86 (0.39 - 1.93)

\$75,000 or more	0.51*** (0.42 - 0.61)	0.37*** (0.25 - 0.56)	1.50 (0.91 - 2.48)	0.81 (0.24 - 2.75)	1.10 (0.74 - 1.66)	0.63 (0.26 - 1.57)
Race/ethnicity						
Non-Hispanic Whites= ref						
Non-Hispanic African Americans	1.00 (0.82 - 1.21)	1.06 (0.80 - 1.41)	1.53 (0.80 - 2.91)	1.82 (0.67 - 4.95)	1.69* (1.02 - 2.79)	2.06 (0.96 - 4.38)
Hispanics	0.77* (0.63 - 0.94)	0.97 (0.69 - 1.36)	0.96 (0.55 - 1.68)	1.34 (0.58 - 3.11)	0.92 (0.58 - 1.44)	1.15 (0.60 - 2.18)
Other race/ethnicity	0.98 (0.77 - 1.23)	0.95 (0.73 - 1.23)	1.32 (0.65 - 2.68)	1.50 (0.67 - 3.39)	1.30 (0.73 - 2.32)	1.24 (0.65 - 2.36)
Education						
High school or less= ref						
High school or more	0.62*** (0.52 - 0.75)	0.44*** (0.29 - 0.66)	1.14 (0.70 - 1.86)	0.53 (0.20 - 1.43)	0.83 (0.56 - 1.23)	0.43* (0.19 - 0.94)
Urbanicity						
large metropolitan = ref						
Small metropolitan	1.09 (0.94 - 1.25)	1.13 (0.96 - 1.33)	1.35 (0.89 - 2.04)	1.31 (0.80 - 2.12)	1.06 (0.75 - 1.51)	1.02 (0.68 - 1.52)
Non-metropolitan	0.96 (0.80 - 1.15)	1.09 (0.89 - 1.34)	1.72* (1.02 - 2.90)	1.91* (1.06 - 3.45)	1.31 (0.86 - 1.99)	1.44 (0.89 - 2.31)
Health status						
Fair/poor = ref						
Good health	0.69*** (0.58 - 0.83)	0.68** (0.53 - 0.86)	0.53* (0.32 - 0.88)	0.44* (0.21 - 0.91)	0.73 (0.48 - 1.13)	0.64 (0.37 - 1.09)
MDE						

No=ref						
Yes	2.66*** (2.30 - 3.09)	2.65*** (2.24 - 3.13)	0.69 (0.46 - 1.03)	0.74 (0.48 - 1.14)	1.14 (0.81 - 1.63)	1.07 (0.72 - 1.58)
Post ACA						
	1.18* (1.04 - 1.35)	1.02 (0.83 - 1.26)	1.46 (0.98 - 2.17)	1.01 (0.51 - 1.98)	1.20 (0.86 - 1.67)	0.96 (0.60 - 1.52)

Adjusted Wald test found that self-employment variable was strong with $F = 40.21$ ($p < 0.001$)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval. Ref= Reference

Table 1-8. Adjusted associations of treatment utilization and different types of health insurance coverage, controlling for sociodemographic characteristics and post ACA, among people with OUD and used opioid less than a year

	Any SUD treatment	TOOS only	Any TOOS
Sample size	3,241	376	899
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Health insurance			
No insurance = reference			
Medicaid	2.31*** (1.66 - 3.21)	3.66** (1.46 - 9.20)	2.69** (1.32 - 5.47)
Private	1.11 (0.81 - 1.52)	2.06 (0.88 - 4.84)	2.65** (1.28 - 5.47)
Medicare and others	1.49 (0.85 - 2.63)	0.57 (0.12 - 2.75)	1.58 (0.35 - 7.18)
Age in years			
18-25= reference			
26-34	1.04 (0.81 - 1.33)	1.36 (0.61 - 3.05)	1.78 (0.86 - 3.68)
35-49	1.11 (0.83 - 1.47)	0.97 (0.42 - 2.22)	0.87 (0.41 - 1.84)
50-64	0.95 (0.54 - 1.65)	1.68 (0.23 - 12.37)	3.85 (0.65 - 22.83)
Sex			
Female= reference			
Male	1.29* (1.00 - 1.67)	0.70 (0.36 - 1.37)	0.96 (0.52 - 1.75)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.69 (0.45 - 1.07)	1.31 (0.33 - 5.21)	3.27 (0.85 - 12.54)
Hispanic	0.54** (0.37 - 0.78)	0.45 (0.16 - 1.32)	0.71 (0.27 - 1.87)
Other race/ethnicity	0.30*** (0.18 - 0.49)	0.53 (0.14 - 2.03)	0.59 (0.20 - 1.73)
Education			
High school or less=ref			
High school or more	1.15 (0.86 - 1.53)	1.31 (0.55 - 3.10)	0.76 (0.36 - 1.63)
Total annual family income			
< \$50,000= ref			
\$ 50,000-74,999	1.06 (0.74 - 1.51)	1.26 (0.53 - 2.96)	0.92 (0.44 - 1.92)

75,000 or more	0.71* (0.52 - 0.97)	1.84 (0.72 - 4.73)	1.42 (0.67 - 3.02)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	0.77* (0.59 - 1.00)	2.61* (1.09 - 6.26)	2.05 (0.92 - 4.54)
Non-metropolitan	0.66** (0.49 - 0.90)	2.34* (1.07 - 5.10)	1.70 (0.85 - 3.38)
Health status			
Fair/poor= ref			
Good health	1.00 (0.74 - 1.36)	0.75 (0.33 - 1.69)	0.88 (0.41 - 1.93)
Major Depression Episode (MDE)			
No= ref			
Yes	1.44** (1.11 - 1.87)	0.91 (0.45 - 1.85)	1.18 (0.66 - 2.14)
Post ACA			
	1.41** (1.10 - 1.81)	0.73 (0.38 - 1.43)	1.07 (0.62 - 1.84)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-9. Summary table for the adjusted associations between health insurance types and any past year SUD treatment utilization

	Any SUD AOR (95%CI)	Any AUD AOR (95%CI)	Any OUD AOR (95%CI)
<i>Main results</i>			
No insurance = reference			
Medicaid	2.07*** (1.78 – 2.40)	1.87*** (1.54 – 2.27)	2.18*** (1.63 – 2.91)
Private	0.64*** (0.55 – 0.73)	0.71*** (0.60 – 0.85)	1.03 (0.78 – 1.36)
Medicare and others	1.29* (1.03 – 1.61)	1.43** (1.09 – 1.87)	1.55 (0.94 – 2.57)
<i>Sensitivity analysis with interaction</i>			
No insurance = reference			
Medicaid	1.98*** (1.62 - 2.43)	1.97*** (1.52 - 2.54)	1.76** (1.20 - 2.59)
Private	0.68*** (0.57 - 0.81)	0.74** (0.60 - 0.92)	1.11 (0.79 - 1.55)
Medicare and others	1.35* (1.00 - 1.82)	1.42* (1.00 - 2.02)	1.54 (0.82 - 2.89)
Post ACA	1.33* (1.07 - 1.66)	1.28 (0.97 - 1.68)	1.50 (0.95 - 2.38)
Post ACA* Uninsured = ref			
Post ACA * Medicaid	1.06 (0.79 - 1.42)	0.86 (0.58 - 1.26)	1.56 (0.86 - 2.80)
Post ACA * Private	0.84 (0.64 - 1.10)	0.86 (0.62 - 1.21)	0.86 (0.49 - 1.51)
Post ACA * Medicare and other	0.87 (0.56 - 1.35)	0.98 (0.58 - 1.66)	1.03 (0.37 - 2.89)
<i>Sensitivity analysis for those with substance problem less than a year</i>			
No insurance = reference			
Medicaid	N/A	1.87*** (1.54 – 2.27)	2.31*** (1.66 - 3.21)
Private	N/A	0.71*** (0.60 – 0.85)	1.11 (0.81 - 1.52)
Medicare and others	N/A	1.43** (1.09 – 1.87)	1.49 (0.85 - 2.63)

Note: All of people with AUD in the final analytic sample had alcohol problem less than a year

***p<0.001, **p<0.01, *p<0.05 AOR= Adjusted Odd Ratios, CI= Confidence Interval. Ref= Reference

Table 1-10. Summary table for the adjusted associations between health insurance types and any past year utilization of TOOS approach (vs. self-help)

	Any SUD		Any AUD		Any OUD	
	TOOS only	Any TOOS	TOOS only	Any TOOS	TOOS only	Any TOOS
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Main results						
No insurance = ref						
Medicaid	1.97** (1.30 - 3.00)	2.05*** (1.44 - 2.92)	1.90* (1.10 - 3.30)	1.86** (1.18 - 2.93)	2.45* (1.18 - 5.10)	2.38** (1.29 - 4.38)
Private	1.16 (0.78 - 1.72)	1.18 (0.84 - 1.65)	1.23 (0.77 - 1.99)	1.15 (0.77 - 1.71)	1.71 (0.79 - 3.73)	2.02 (1.00 - 4.10)
Medicare and others	0.77 (0.41 - 1.46)	0.93 (0.52 - 1.65)	1.04 (0.48 - 2.27)	0.94 (0.48 - 1.86)	0.52 (0.14 - 1.95)	0.84 (0.25 - 2.88)
Sensitivity results with interaction						
No insurance = ref						
Medicaid	2.60** (1.44 - 4.68)	2.51*** (1.50 - 4.18)	2.06 (1.00 - 4.26)	1.86 (1.00 - 3.47)	5.18** (1.61 - 16.68)	5.94** (2.03 - 17.42)
Private	1.01 (0.61 - 1.66)	1.00 (0.66 - 1.51)	1.00 (0.55 - 1.79)	0.91 (0.56 - 1.48)	2.15 (0.84 - 5.51)	1.94 (0.88 - 4.28)
Medicare and others	0.44 (0.19 - 1.04)	0.65 (0.32 - 1.31)	0.55 (0.19 - 1.58)	0.63 (0.27 - 1.45)	0.26 (0.05 - 1.36)	0.60 (0.15 - 2.39)
Post ACA	1.17 (0.65 - 2.13)	0.97 (0.60 - 1.57)	0.94 (0.44 - 2.01)	0.71 (0.38 - 1.29)	1.55 (0.54 - 4.39)	1.48 (0.60 - 3.63)
PostACA* Uninsured= ref						
Post ACA* Medicaid	0.66 (0.28 - 1.53)	0.78 (0.38 - 1.60)	0.96 (0.31 - 2.98)	1.20 (0.49 - 2.98)	0.30 (0.06 - 1.46)	0.25 (0.06 - 1.05)
Post ACA* Private	1.42 (0.65 - 3.08)	1.62 (0.85 - 3.06)	1.80 (0.69 - 4.70)	2.10 (0.97 - 4.56)	0.59 (0.14 - 2.61)	1.07 (0.31 - 3.71)
Post ACA* Medicare and other	4.27* (0.65 - 2.13)	3.28* (0.60 - 1.57)	5.26* (0.44 - 2.01)	3.89* (0.38 - 1.29)	6.72 (0.54 - 4.39)	4.27 (0.60 - 3.63)

	(1.23 - 14.82)	(1.13 - 9.55)	(1.20 - 23.10)	(1.12 - 13.48)	(0.25 - 178.36)	(0.30 - 60.52)
<hr/> <i>Sensitivity analysis for those with substance problem less than a year</i>						
No insurance = ref						
Medicaid	N/A	N/A	1.90* (1.10 - 3.30)	1.86** (1.18 - 2.93)	3.66** (1.46 - 9.20)	2.69** (1.32 - 5.47)
Private	N/A	N/A	1.23 (0.77 - 1.99)	1.15 (0.77 - 1.71)	2.06 (0.88 - 4.84)	2.65** (1.28 - 5.47)
Medicare and others	N/A	N/A	1.04 (0.48 - 2.27)	0.94 (0.48 - 1.86)	0.57 (0.12 - 2.75)	1.58 (0.35 - 7.18)

Note: All of people with AUD in the final analytic sample had alcohol problem less than a year

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval. Ref= Reference

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Chapter 3 Medicaid expansion and referral sources in non-intensive outpatient treatment for opioid use disorder

Abstract

Despite dramatic increases in opioid-related overdoses in recent years and the predominant role Medicaid plays in paying for medically managed opioid use disorder treatment, there is a lack of research documenting the relationship between Medicaid coverage and healthcare provider referrals to outpatient treatment. This study uses a natural experiment to evaluate whether Medicaid expansion under the Affordable Care Act (ACA) increases healthcare provider referrals to outpatient treatment for opioid use disorder (OUD).

This study uses a two ways fixed effects model (2WFE), a modification to a simple difference-in-difference (DID) model that is more flexible in allowing states to expand Medicaid in different years throughout the study period, to identify the effect of Medicaid coverage on provider referrals to OUD treatment. As a sensitivity test, a simple DID model was also run including only states that expanded in 2014 and states that did not expand by 2017. Data include eight years of Treatment Episode Data Set-Discharge (TEDS-D) dataset spanning 2010 to 2017 representing 382,609 individuals with outpatient OUD treatment. Regression models controlled for state and year fixed effects, medication assisted treatment for OUD, and other covariates including demographic characteristics, having a psychiatric comorbidity, and polysubstance use.

Results from the two-way fixed effects (2WFE) model suggest that Medicaid expansion states were significantly more likely to have outpatient OUD discharges that were referred by healthcare providers (versus self-referred) compared to non-Medicaid expansion states (AOR 1.2, 95% CI: 1.1-1.3). The simple DID estimates (AOR 1.2, 95% CI: 1.1-1.3) were consistent with the 2WFE results.

This study found that Medicaid expansion under the ACA has a positive impact on the likelihood of being referred by healthcare providers for outpatient treatment for OUD. The findings suggest that

Medicaid expansion has the potential to improve timely and effective access to evidence-based treatments for OUD via coverage-related increases in access to healthcare providers.

Introduction

The U.S. has experienced an unprecedented opioid epidemic with 1.6 million people having an opioid addiction in 2017.⁷⁷ According to the Centers for Disease Control and Prevention, overdose deaths in 2019 increased six times compared to 1999 and about two-thirds of all drug overdose deaths were attributed to opioid overdose.⁷⁸ In 2019, nearly 50,000 people died due to such overdose.⁷⁸ Annual opioid costs related to crime, lost work productivity and healthcare were estimated to be more than 78 billion dollars, with 26 billion related to healthcare.⁷⁹ The epidemic has negatively impacted American families and communities, affecting rich and poor, both urban and rural communities.⁸⁰ More recently, an increasing number of providers, patients, and medical societies considers OUD a chronic disease,⁷ and the perspective on substance use treatment has changed accordingly. Understanding OUD as a treatable chronic disease has made room for the emergence of approaches that rely more on the health care system to effectively manage this disease over an extended period of time.⁸ Although effective treatments for opioid use disorder (OUD) including pharmacological and/or psychological therapies exist, more than 80% of those with OUD do not access substance use disorder (SUD) treatment.¹¹

For these reasons, a better understanding of what factors may increase access to substance use treatment is needed. To date, the evidence suggests access-related predictors for OUD treatment include financial barriers, stigma toward substance use,¹² and the extent to which patients understand the health care delivery system and OUD treatment options. Given the shift towards outpatient treatment for OUD, referral sources may also be a critical determinant of timely and effective SUD treatment as well as a strong predictor for treatment success.^{19,20} For example, previous studies demonstrated positive associations of employer and criminal justice referrals with successful treatment completion, while self-referrals and healthcare referrals were negatively associated with successful completion.¹⁶ Recent expansions of outpatient treatment coverage by insurers and medical society recommendations that

emphasize treatment obtained in outpatient settings are expected to lead to an increasing role of the healthcare system in SUD treatment success. This highlights the potential importance of provider referrals to improving outpatient treatment access and outcomes.

Medicaid expansion represents a significant policy shift both because it has increased health insurance coverage for so many individuals with SUD (Medicaid pays for a majority of individuals with SUD³⁵) and because it has increased the supply of treatment providers.²⁴ Thus, Medicaid expansion has been instrumental in reforming the U.S. delivery system for SUD treatment and increase access to SUD treatment.⁶⁶ By enabling states to expand Medicaid eligibility to low-income adults up to 138% of FPL⁸¹ under the Patient Protection Affordable Care Act (ACA), insurance coverage among individuals with SUD has increased in 37 states as of 2020.⁸² Importantly, the ACA also defined SUD as one of ten essential health benefits that must be covered and should be covered on parity with other medical conditions;⁶⁷ however, this benefit could vary by state as the ACA did not specify which SUD services must be included. Prior to the ACA, most low-income people who are in need of medication-assisted treatment (MAT) for OUD were left untreated.⁸³ Evidence suggests that Medicaid expansion has narrowed the treatment gap through increased insurance coverage and other delivery system changes.^{84,85} Indeed, previous studies found that Medicaid expansion has helped reduce the rates of being uninsured among low-income adults with SUD from 36% to 27%.^{21,22} Additionally, admissions to SUD treatment among Medicaid beneficiaries increased 113% as a result of expansion without crowding out admissions from individuals with other types of insurance.²³ Medicaid expansion has also resulted in substantial increases in the use of pharmacological therapy for opioid use disorder (OUD), including methadone and buprenorphine.^{22–24}

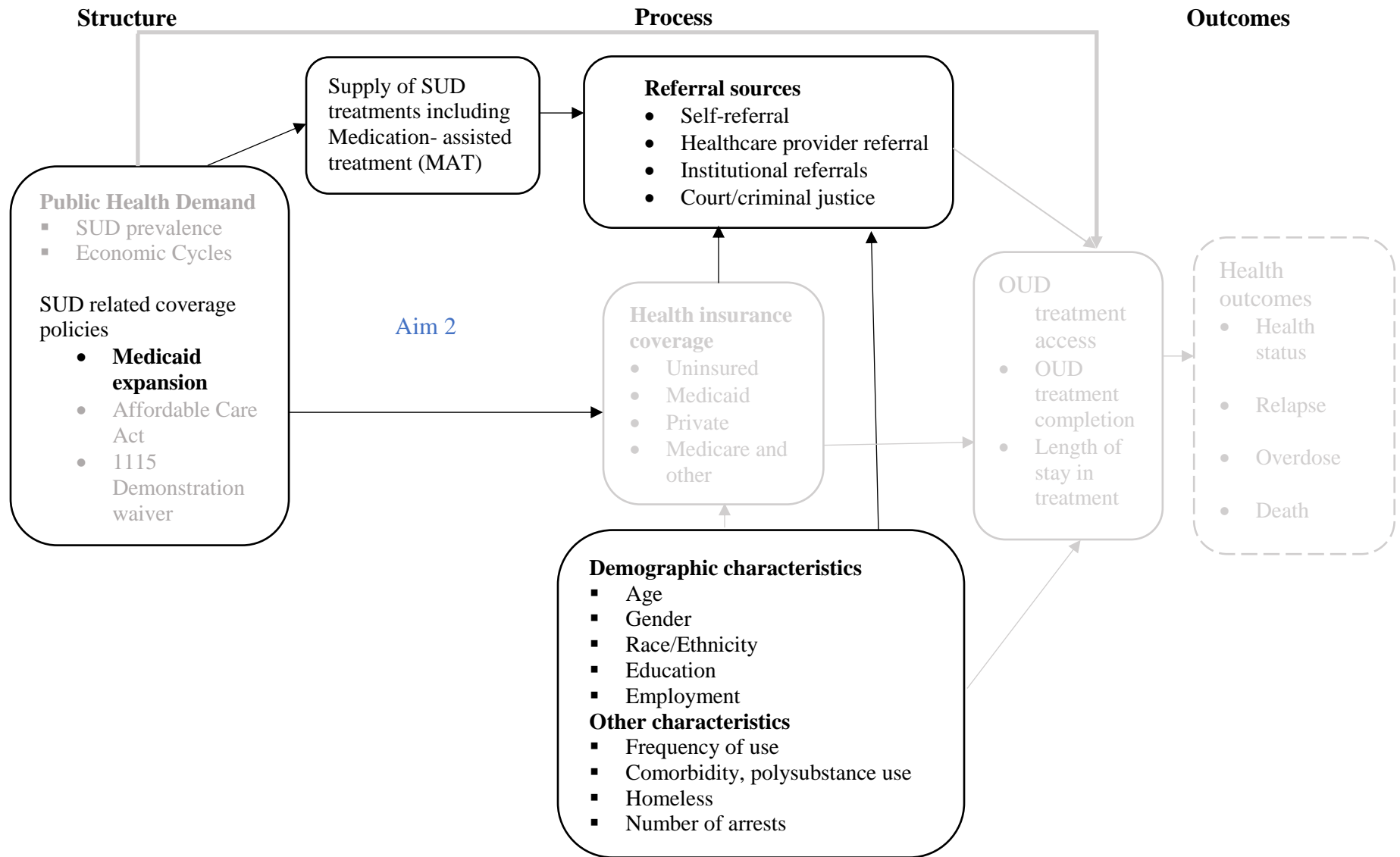
Medicaid policies have emphasized the role of evidence-based outpatient treatment for OUD that focuses on pharmacological therapy, often combined with psycho-social therapy.⁸ This shift should lead

to an increased role of healthcare providers in referring patients to SUD treatment, particularly outpatient treatment, and in the 26 states with Institutions for Mental Diseases (IMD) 1115 demonstration waivers in 2019, to residential treatment.⁸⁶ In other words, Medicaid expansion is expected to increase SUD treatment referrals to health care facilities from healthcare providers, which in turn is expected to increase treatment access, treatment completion, and therefore treatment success. Referral source is thus considered a key factor in timely and effective SUD treatment.^{19,20} However, the existing literature on referral source mostly focused on its role in substance use treatment completion. These studies have found that substance use treatment completion rates differ by referral sources.^{15,16} Employer and criminal justice referral pathways were associated with higher likelihood of successful treatment completion, while self-referrals and healthcare referrals were found to be associated with lower likelihood of successful completion.¹⁶ While referral source plays a significant role in substance use treatment and retention, there is a dearth of studies exploring factors affecting referral sources in general, and healthcare provider referrals specifically.

Despite the evidence that Medicaid expansion has played an important role in reforming the delivery system for SUD treatment, to date we are unaware of any study examining associations between this expansion and healthcare provider referrals.

Conceptual model

Figure 4. Conceptual model of Medicaid expansion and referral source



The conceptual model above is adapted from the Donabedian framework that describes the associations of structure, process, and outcomes in the healthcare system (figure 1).⁸⁷ “Structure” includes substance use related coverage policies (e.g., Medicaid expansion, ACA, 1115 Demonstration Waivers). Referral source is considered “process” that is influenced by the structure factors such as Medicaid expansion. The “structure” and “process” influence outcomes including OUD treatment access and utilization. The conceptual model above suggests that Medicaid expansion should increase the likelihood of being referred to outpatient OUD treatment by healthcare providers.

Study aim

To explore associations between Medicaid expansion and referral sources to outpatient treatment for OUD, including healthcare provider referral.

Hypothesis

Medicaid expansion increases the likelihood of being referred to outpatient treatment for OUD by healthcare providers in expansion states compared to non-expansion states.

Methods

Overview of design and data

This study uses a quasi-experimental difference-in-differences (DID) with two-ways fixed effects (2WFE) approaches to explore the relationships between Medicaid expansion and referral sources.^{21,24} Data were obtained from the publicly available TEDS-D, a national data system of annual discharges from publicly funded substance treatment facilities. They included the following types of facilities and services: (1) 24 hour per day medical acute care services in hospital settings, (2) 24 hour per day services in non-hospital settings, (3) rehabilitation in hospital settings, (4) short-term residential rehabilitation, (5) long-term residential rehabilitation, (6) intensive outpatient/ambulatory care, (7) non-intensive outpatient/ambulatory care, and (8) outpatient/ambulatory detoxification.

The TEDS-D surveys were conducted by both the federal government and state agencies to collect information on SUD treatment programs, providing detailed information on the demographic characteristics of those who accessed treatment including age, gender, race/ethnicity, education, employment; information on drug use history, MAT (e.g., the use of opioid medications such as methadone, buprenorphine, naltrexone), homeless status, number of arrests, and referral source. TEDS surveys collected information on SUD treatment from publicly-funded facilities which accounted for more than 50% of SUD treatment facilities nationally.⁸⁸ TEDS-D had 12 waves of data (from 2006 to 2017; not counting for the year 2018 which has just been released), enabling researchers to combine many waves of data to increase statistical power and policy relevance. This study used 2010-2017 TEDS-D data to assess the impact of Medicaid expansion under the ACA on referral sources. Data from 2010-2017 were chosen in order to have 4 years (2010-2013) of data before ACA implementation (2014) and 4 years (2014-2017) of data after implementation.

Sample

OD population. The OUD population included all discharges from the 2010-2017 TEDS-D whose primary substance use at admission had been opioids. This resulted in a sample of 3,628,633 observations. We first excluded discharges from Puerto Rico ($n = 3,025$) given that the Medicaid expansion operates differently in the territories (e.g., Puerto Rico) as well as the differences between territories and the states in demographic, health status, and economic indicators.⁸⁹ The sample age range was limited to 18-64 years since expanded Medicaid under the ACA was aimed to increase coverage for low-income working-age adults.⁹⁰ This resulted in a sample of 3,502,661 observations. Further, as has been done in previous work,⁹¹ discharges with a prior admission in their lifetime ($n=2,279,678$) were

excluded as there was no way to link multiple discharges to a unique patient identifier. Further, discharges due to incarceration, or death, or that were missing were also excluded (n=47,916).

Additionally, as this study focuses on the role of Medicaid expansion on referrals to outpatient OUD treatment, all discharges other than non-intensive outpatient were excluded (i.e., excluding the discharges from 24 hour per day medical acute care services in hospital setting, 24 hour per day services in non-hospital setting; residential rehabilitation in hospital, residential rehabilitation, short-term; residential rehabilitation, long term; ambulatory, intensive outpatient) (n=764,885) (Table 2-1) . This resulted an analytic sample of 382,609 discharges aged 18-64 years old, with no prior admission in their lifetime with non-intensive outpatient treatment for OUD (For a sample flow chart, see Appendix 2-A).

Table 2-1. Service types at admissions for opioid treatment

Service types at admission	Frequency	Percent
(1) 24 hour per day medical acute care services in hospital settings	117,940	10.28
(2) 24 hour per day services in non-hospital settings	333,324	29.05
(3) Rehabilitation in hospital settings	4,013	0.35
(4) Short-term residential rehabilitation	104,094	9.07
(5) Long term residential rehabilitation	59,914	5.22
(6) Intensive outpatient/ambulatory care	104,358	9.09
(7) Non-intensive outpatient/ambulatory care	382,609	33.34
(8) Outpatient/ambulatory detoxification.	41,242	3.59
Total	1,147,494	100

Measures

Referral source (Process)

This variable of interest was constructed as a four-level categorical variable: self-referral, care provider, other institutional referral, court/criminal justice referral. Self-referral was defined as an individual who referred him/herself to the substance use treatment (52.7%). The healthcare provider referral category (13.2%) combined referrals from alcohol/drug care providers (4.9%) and other

healthcare providers (8.3%). The other institutional referral source category (10.1%) combined referrals from school (0.2%), employers (0.3%), and community services (9.6%). The category court/criminal justice referral/DUI/DWI included discharges who were referred by court or criminal justice (22.2%). About 1.8% discharges were defined as missing/unknown/not collected/invalid and are excluded from the analyses that follow.

Medicaid expansion (Structure)

As is described in more detail below, the effect of Medicaid expansion on the source of referrals to outpatient OUD treatment was tested with two different empirical approaches – a two-way fixed effects (2WFE) model and a difference-in-difference (DID). Each of these approaches necessitates a slightly different empirical definition of the Medicaid expansion policy variables. For the two-ways fixed effects model, the key independent variable of interest was defined as whether the state implemented Medicaid expansion under the ACA in a given survey year. For each survey year, we constructed a binary variable receiving the value of 1 if discharges were from states that adopted Medicaid expansion in that year, and 0 if discharges were from a state that did not expand Medicaid in that year. As of 2017, 31 states and District of Columbia expanded Medicaid expansion in which 27 states and District of Columbia expanded the Medicaid in 2014 (*early expansion*) and 5 states expanded between 2015 and 2017, the last year of TEDS-D data included in these analyses (*late expansion*) (See Appendix Table 1 for summary of Medicaid expansion).⁹² This approach allowed us to assess the impact of Medicaid expansion on the referral sources, taking into account the fact that states expanded Medicaid in different years.⁹³

In the second empirical approach, the simple DID model, the independent variable of interest for DID was the interaction whether the discharge was from a facility located in a state with Medicaid expansion and an indicator for whether the discharge occurred in a year after that state expanded

Medicaid. In this approach, only *early expansion*, those that expanded Medicaid in 2014, were included and compared to states that never expanded Medicaid as of 2017.

Covariates

The association between Medicaid expansion and referral source was adjusted for state fixed effects and year fixed effects to capture unobserved state heterogeneity and national secular trends in access to SUD treatment (e.g., the prevalence of opioid use).^{21,24} Demographic characteristics that are available in TEDS-D and used as covariates included age (18-29, 30-44, 45-64 years old), gender (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, other), education (less than high school, high school or higher), employment status (employed, not employed).

In addition, we controlled for whether patients used MAT (yes/no), frequency of opioid use (no use in the past month, some use, daily use), homeless at the time of admission (yes/no), number of times arrested in the 30 days prior to admission (no, one, two or more), psychiatric comorbidity (i.e., whether patient had psychiatric problem in addition to their substance use) (yes/no), and polysubstance use (no other substance, one more substance other than opioids, two or more substances other than opioids).^{38,91}

Statistical analysis

We first ran a 2WFE model to examine the impact of Medicaid expansion on referral sources using multinomial logit model to account for the fact that the states expanded Medicaid expansion under the ACA in different years.

$$Y = \beta_0 + \beta_1 \text{Medexp}_{st} + \beta X + S + T + \varepsilon. \quad (1)$$

Where Y is the outcome of interest, which is a categorical variable including self-referral, healthcare provider referral, other institutional referral, court/criminal justice referral. Medexp_{st} is the independent variable, equals to 1 if discharges were from the state s that expanded Medicaid in year t and 0

otherwise, X represents a matrix of individual-level control variables, S represents state fixed effects, and T represents year fixed effects.

We then restricted the analysis sample to states that adopted Medicaid expansion in 2014 and states that did not adopt Medicaid expansion as of 2017. For estimating associations between Medicaid expansion and the referral source, we used a standard DID design with state and year effects. We used the state fixed effect in order to account for unobserved state heterogeneity, whereas we used year fixed effect to account for the national secular trends that might be systematically correlated with Medicaid expansion.

$$Y = \beta_0 + \beta_1 \text{Exp}_s + \beta_2 \text{PostExpansion}_t + \beta_3 \text{Exp}_s * \text{PostExpansion}_t + \beta X + S + T + \epsilon. \quad (2)$$

Again, Y is the referral source outcome of interest, including referred by healthcare provider, Exp_s is the independent variable, equal to 1 if the discharges were from the *early expansion* states and 0 otherwise; PostExpansion_t is a binary variable indicating the period after early Medicaid expansion (year 2014); $\text{Exp}_s * \text{PostExpansion}_t$ is the interaction of Medicaid expansion and PostExpansion, with X representing a matrix of individual-level control variables, S denoting state fixed effects, and T denoting year fixed effects.

Sensitivity analyses

For valid identification of the effect of Medicaid expansion on referral sources, the DID design has several assumptions that should be met.⁹⁴ Particularly, if the comparison groups have different trends in the outcome of interest prior to the policy change, then the DID design is not necessarily an appropriate design as it violates the parallel trend assumption that may lead to biased estimate of causal effect. To mitigate this concern, we included multiple waves of data in the pre-expansion period (2010-

2013), which allows us to test the parallel trend assumption.⁹⁵ The assumption of DID approach is that the trends in referral source among the expansion and non-expansion groups is parallel in the time prior to the expansion implementation date (year 2014). We tested the assumption by assessing interactions of expansion status and year variable in the pre-expansion period, we created line graphs to visualize the outcomes of interest (i.e., trends in self-referrals, healthcare provider referrals, institutional referrals, court/criminal justice referrals) over time. Furthermore, in order to correct for the within serial correlation in a DID context, we clustered the standard errors at the state level.

As non-intensive outpatient treatments service settings may include MAT and non-MAT (e.g., individual, family and/or group services), we ran a sensitivity analysis of the associations between Medicaid expansion and referral sources stratified by MAT.

In addition, the associations were also adjusted for variables directly affecting the supply of and demand for opioids at the state level that vary over time including prescription drug monitoring program (PDMP) implementation, and economic conditions including unemployment rates for each state, which was obtained from the Bureau of Labor Statistics' Local Area Unemployment Statistics. We collected effective dates of PDMP implementation and verify via different sources including PDMP websites, the Prescription Drug Abuse Policy System. We conducted sensitivity analysis to estimate the associations and account for the economic conditions and prescription drug monitoring program implementation. Further, given that the Section 1115 Demonstration waivers also play a significant role in improving SUD delivery system and coverage,²¹ we also checked the robustness of the main finding by including indicator variables states with Section 1115 waiver in a given survey year. We also checked the robustness of the main findings by re-estimating the association by including one-year lag after Medicaid expansion. Finally, we also conducted a sensitivity analysis that examined the associations for

those with more than one treatment episodes as it is common that many of those with OUD experienced many episodes of treatment.

Results

Sample characteristics

Table 2-2 shows characteristics of discharges from non-intensive outpatient treatment for opioids from 2010 to 2017, TEDS-D (N= 382,609). Most discharges were self-referred (more than 50%), followed by court/criminal justice referral (23%), and healthcare provider referral (13%). More than one third of the discharges included MAT services. More than half of individuals discharged used opioids daily before accessing outpatient treatment. With regards to demographic characteristics, a majority of individuals were 30-44 years old, male, non-Hispanic White, with high school education or higher, had not been arrested, and were employed. About one-third suffered from a psychiatric comorbidity. More than half used at least one more substance in addition to opioids.

Figure 5 shows the change in numbers of discharges by referral sources from 2010-2017 TEDS-D. Overall, there was an increase of 67 % in number of discharges in outpatient treatment for opioids from 39,699 discharges in 2010 to 65,793 discharges in 2017. Notably, there was a sudden increase in discharges from 2014-2017 (+23,203 discharges), compared to 2010 to 2014 (+3,000 discharges). We also saw the increases in discharges that were referred by all referral sources except for court/criminal justice referrals.

Trends in referral sources across Medicaid expansion states versus non-expansion states

Figure 6 presents trends in referral sources including self-referral, healthcare provider referral, other institutional referral, and court/criminal justice referral, for non-intensive outpatient treatment for opioids for Medicaid expansion states (including *early expansion* in 2014 and *late expansion* after 2014)

versus non-expansion states. Line graphs were created to visualize the parallel assumption. The assumption of DID approach is met if the trends in discharges by referral source (i.e., self-referrals, healthcare provider referrals) among the expansion and non-expansion groups are parallel in the time prior to the expansion implementation date (i.e., Medicaid expansion under ACA in 2014). Overall, for all referral sources, higher numbers of discharges were reported from early expansion states than non-expansion states. Before ACA implementation, trends in self-referred discharges and healthcare provider discharges were similar across both *early expansion* and non-expansion states. After ACA implementation, there was an increase in the number of discharges in both self-referral and healthcare provider referral in early expansion states but a decrease in non-expansion states, except in the year 2017, when we observed discharges with self- or provider referral increasing in non-expansion states. On the other hand, trends in self-referred discharges and healthcare provider referred discharges for *late expansion* states seemed to violate the parallel assumption.

Adjusted association results from 2WFE and DID models

Table 2-3 presents the adjusted estimates from the 2WFE model taking into account the fact that states expanded their Medicaid expansion in different times. The results showed that Medicaid expansion states were significantly more likely to have discharges that were referred by healthcare provider (versus self-referred) compared to non-Medicaid expansion states (Relative Risk Ratio (RRR) 1.2, 95% CI: 1.1-1.3). Compared with non-expansion states, Medicaid expansion states also were more likely to have discharges that were referred by other institution (RRR: 2.3, 95%CI: 2.1-2.4) and court/criminal justice (RRR: 1.3, 95% CI: 1.2-1.4) compared to self-referrals.

Table 2-4 presents the adjusted estimates from DID model, using multinomial logistic regression comparing healthcare provider referral, other institutional, court/ criminal justice referral sources, with self-referral source. After adjusting for state and year fixed effects, and other covariates, the DID

estimate indicated that state implementation of Medicaid expansion in 2014 was associated with an increase in likelihood of being referred by healthcare provider (vs. self-referral) (RRR 1.2, 95% CI: 1.1-1.3), as was observed in the two-way fixed effects model. The Medicaid expansion was also positively associated with the likelihood of being referred by other institutional referrals (RRR 2.4, 95% CI: 2.2-2.6) and court/criminal justice referral (RRR 1.3, 95% CI: 1.2-1.4), again consistent with the results from the two-way fixed effects specification described above.

Table 2-5 presents the adjusted estimates from the 2WFE model among non-MAT, non-intensive outpatient treatment for OUD. The results showed that compared with non-expansion states, Medicaid expansion states were more likely to have discharges that were referred by healthcare provider (versus self-referred) (RRR 1.2, 95% CI: 1.1-1.2). Compared with non-expansion states, Medicaid expansion states also were more likely to have discharges that were referred by other institution (RRR: 2.4, 95% CI: 2.2-2.5) or court/criminal justice (RRR: 1.3, 95% CI: 1.2-1.3).

Table 2-6 presents the adjusted estimates from the 2WFE model among individuals receiving MAT and in non-intensive outpatient treatment for OUD using logit models. The adjusted two-ways fixed effect model suggests that Medicaid expansion was not significantly associated with an increase in likelihood of being referred by healthcare providers (vs. self-referral).

Table 2-7 presents the adjusted estimates from DID model for non-MAT, non-intensive outpatient treatment for OUD. The adjusted DID estimate indicated that state implementation of Medicaid expansion in 2014 was associated with an increase in likelihood of being referred by healthcare provider (vs. self-referral) (RRR 1.2, 95% CI: 1.1-1.3). The Medicaid expansion was also positively associated with the likelihood of being referred by other institutional referrals (RRR 2.5, 95% CI: 2.3-2.7) or court/criminal justice referral (RRR 1.3, 95% CI: 1.2-1.3).

Table 2-8 presents the adjusted estimates from DID model for MAT, non-intensive outpatient

treatment for OUD. The adjusted DID estimate indicated that state implementation of Medicaid expansion in 2014 was positively associated with the likelihood of being referred by other institutional referrals (RRR 2.2, 95% CI: 1.8-2.7) and court/criminal justice referrals (RRR 1.3, 95% CI: 1.01-1.7). However, the adjusted DID estimate indicated that state implementation of Medicaid expansion in 2014 was not significantly associated with an increase in likelihood of being referred by healthcare provider (vs. self-referral).

Sensitivity analysis results

Table 2-C shows the sensitivity analysis results when we added states' unemployment rates and PMDP policies in the 2WFE model (Table 2-C1) and from DID model (Table 2-C2). Compared with non-expansion states, the adjusted 2WFE estimates showed that Medicaid expansion states were positively associated with increased likelihood of being referred by healthcare providers (RRR 1.1, 95% CI: 1.1-1.2), other institutions (RRR: 2.1, 95% CI: 2.0-2.3), court/ criminal justice (RRR: 1.3, 95% CI: 1.2-1.4) compared to self-referrals. These results were consistent with the main model results (Table 2-3), as well as the sensitivity results from the DID model (Table 2C-2).

Table 2-D presents the sensitivity analysis results from lagged DID model. Medicaid expansion had a positive effect in the likelihood of being referred by healthcare providers (vs. self-referrals) in year 2 of the expansion (RRR 1.2, 95% CI: 1.06-1.33), and year 3 of the expansion (RRR 1.2, 95% CI: 1.04-1.27). On the other hand, Medicaid expansion had a positive effect in year 3 of the expansion for institutional referrals (RRR 1.4, 95% CI: 1.19-1.54), court/criminal justice referrals (RRR 1.5, 95% CI: 1.37- 1.65).

Tables 2-E1 to 2-E6 show the sensitivity analysis results for discharges with more than one episode of non-intensive outpatient opioid treatment from the 2WFE and DID models, for both pooled

sample and MAT or non-MAT stratification. Medicaid expansion was negatively associated with the likelihood of being referred by healthcare providers (RRR 0.9, 95 % CI: 0.88-0.95) but positively associated with the likelihood of being referred by institutional referrals (RRR 1.3, 95% CI: 1.3-1.4) (Table 2-E1). These were consistent with the DID model results (Table 2-E2) and stratified by MAT (Tables 2E3 and 2E4). In addition, we also saw the positive effect of Medicaid expansion on the likelihood of being referred by court/criminal justice referrals among those who used MAT in their outpatient treatment (Table 2-E4). The sensitivity analysis results for discharges with one more episode of treatment with regards to Medicaid expansion and likelihood of being referred by healthcare providers were not consistent with the results from main model for non-prior treatment episode discharges.

Appendix 2-F shows the sensitivity analysis results when we added indicators states' 1115 Waiver Demonstrations for SUD. The adjusted estimates from 2 WFE showed Medicaid expansion was positively associated with the likelihood of being referred by healthcare providers (vs. self-referrals) (RRR 1.2, 95% CI: 1.1-1.2), institutional referrals (RRR 2.3, 95% CI: 2.1-2.4), and court/criminal justice (RRR 1.3, 95% CI: 1.2- 1.4) (Table 2F-1). These results were consistent with the main model results (Table 2-3) as well as the sensitivity analysis results from the DID model (Table 2-F2). Additionally, we saw a higher likelihood of being referred by healthcare providers, institutional referrals, and court/criminal justice referrals (vs. self-referrals) compared to states that did not implement the 1115 Waivers; however, the associations were not significant, except for institutional referrals (RRR 1.2, 95% CI 1.1-1.4) (Table 2-F1).

Summary of adjusted associations between key covariates and referral sources

In general, the adjusted associations using the 2WFE model showed that being employed, having

a psychiatric comorbidity, being homeless, no history of arrest were positively associated with the likelihood of being referred by healthcare providers while males were negatively associated with the likelihood of being referred by healthcare providers (vs. self-referred). For example, discharges with psychiatric comorbidity were associated with 48% increase (95% CI: 1.4-1.5) in the likelihood of being referred by healthcare providers in non-intensive outpatient treatment for OUD (Table 2-3). However, having a psychiatric disorder, being employed, being homeless were less likely to be referred by court/criminal justice while males were more likely to be referred by court/criminal justice (vs. self-referred).

Discussion

This study explored whether Medicaid expansion under the ACA was associated with changes in referral sources to OUD treatment, specifically whether expansion increased the likelihood of being referred by healthcare providers to outpatient treatment. Using TEDS-D data from the year 2010 to 2017 when many states started to implement Medicaid expansion and expanded access to evidence-based treatments for OUD, we found that Medicaid expansion was positively associated with the likelihood of healthcare provider referrals (versus self-referrals) to non-intensive outpatient treatment for OUD.

These results provide the first empirical evidence of the positive impact of Medicaid expansions under the ACA on healthcare provider referral to outpatient treatment for OUD. Specifically, we found expansion was associated with an 18% increase (95% CI: 1.1-1.3) in the likelihood of referral to outpatient OUD treatment by a healthcare provider. The main findings were consistent between the 2WFE model and the simple DID model with regards to the magnitude, direction, and compactness of the estimated likelihood of being referred to outpatient treatment by healthcare provider (vs. self-referral). One reason for the similarity was that the 5 *late expansion* states (i.e., Louisiana, Montana,

Alaska, Indiana, and Pennsylvania) excluded in the DID model, only accounted for an exclusion of 9,875 observations out of 382,609 observations included in the 2WFE model. Specifically, the 9,875 observation that were deleted were from Louisiana (n=1,295), Montana (n=837), Alaska (n=675), Indiana (3,415), and Pennsylvania (n=3,653). Thus, the removal of the 5 *late expansion* states (with a small number of observations) in the DID model did not appear to substantially change the Medicaid expansion estimates observed in the 2WFE model. Our main results were robust and were consistent with the sensitivity analysis results for non-MAT subpopulation, additional covariates (i.e., unemployment rates and PDMP), and sensitivity analysis that added section 1115 Demonstration Waiver. Even though we saw a positive effect of Medicaid expansion on the increased likelihood of being referred by healthcare providers for those who received MAT in non-intensive outpatient treatment, we have not found a statistically significant association. This was probably due to a smaller sample size for those who received MAT only, who accounted for about one third of those who used non-intensive outpatient treatment. In addition, Medicaid policy probably takes time to have an effect on the referral system including healthcare provider system.

Findings from this study add to the literature on the role of Medicaid expansion on the OUD treatment delivery system, by highlighting its impact on the likelihood of healthcare provider referrals to outpatient treatment. Previous studies on the effects of Medicaid expansion on OUD treatment mostly focused on its impact via increasing health insurance coverage, and increasing access to and use of medications for OUD, such as buprenorphine.^{21,24,96,97} Our study emphasizes the role of Medicaid expansion on the referral system through increasing the likelihood of being referred by healthcare providers who should play significant role in opioid use disorder treatment. A previous study pointed out that referrals to substance use treatment by healthcare providers were associated with more accurate diagnoses. This should increase the likelihood that referral will be for the appropriate treatment at the

appropriate level of care.⁹⁸ The current study suggests that Medicaid expansion has the potential to improve the referral system and increase access to timely and effective evidence-based treatments for OUD. Ongoing Medicaid expansion efforts should focus on further documenting and supporting healthcare providers' role in accurately diagnosing OUD and referring patients to an appropriate level of care.

The finding on the positive association of Medicaid expansion on healthcare provider referral offers some interesting insights into the role of Medicaid expansion on the referral system where healthcare providers should play an important role in referring individuals in need of treatment to evidence-based treatments for OUD. In addition, referrals from healthcare providers suggests better opportunity for screening and referrals to treatment needed given that many of those with OUD also suffered from other health conditions including psychiatric problems, chronic diseases, and other infection diseases such as HIV/AIDS and Hepatitis C.^{99,100} In addition, Phillip and his colleagues found that healthcare providers referrals to MAT were associated with a decreased risk of discharges due to incarceration, compared to criminal justice referrals as well as self-referrals.³⁸ Our study found that healthcare provider referrals were not the most common referral source; instead, most patients were either self-referred (more than 50%) or referred by the court/criminal justice (more than 30%). However, we saw an increasing number of discharges that were referred by healthcare providers over time. Furthermore, our study findings were consistent with previous studies that mostly focused on the court/criminal justice referral source with regards to the associations between key characteristics and referral sources. Further, our study findings indicated key characteristics that were associated with the increased likelihood of being referred by healthcare providers. These characteristics included being employed, having psychiatric comorbidities, homeless, and no history of arrested.

Limitations

This study's finding should be interpreted with some caution. First, the generalizability of this study may only apply to a specific population that is accessing substance use treatment for the first time, aged 18 to 64 years old, in non-intensive outpatient treatment for OUD, and only those receiving treatment in a publicly funded facility. A previous study comparing National Survey of Substance Abuse Treatment (N-SSATS) and TEDS pointed out that TEDS was a subset of the facilities that reported to N-SSATS. Specifically, facilities in TEDS accounted for about 50% of all SUD treatment facilities nationwide.¹⁰¹ Given that privately funded SUD treatment increased substantially in recent years, especially under the ACA's Medicaid expansion,¹⁰² the omission of this treatment type may limit the generalizability of this study's findings. In addition, TEDS-D does not include all community health centers, half of which offer SUD treatment services. Previous studies that examined the association between Medicaid expansion and community health centers also showed the positive role of Medicaid expansion on capacity of community health centers.^{103,104} In addition, some states (e.g., West Virginia, Georgia, Oregon) did not report data in the years 2015 to 2017, which could affect the generalizability of our estimates. Furthermore, TEDS-D does not have information on dates of discharges, so including discharges that occurred earlier in the year a state expanded Medicaid could result in a conservative bias. In addition, it takes time for substance use-related policies to improve the treatment system including the referral system.^{96,105} Thus, we anticipate seeing more significant improvement over time in the likelihood of discharges that were referred by healthcare providers in outpatient treatment setting.

This study's finding should also be interpreted in consideration of the advantages and limitations of TEDS-D. One advantage of using TEDS-D is that it is a large national dataset and representative of publicly funded outpatient treatment for opioid use disorder in real-world treatment settings. TEDS-D also has comprehensive information on demographic characteristics, substance use history, referral sources, and treatment settings. Further, TEDS-D has state-level information that enabled us to use the

DID model as well as incorporate state level information (e.g., unemployment rates and PDMP). However, TEDS-D also has several limitations. The first limitation is that TEDS-D is a discharge-level dataset and does not have identifiable information to link different discharges of the same individual. Including multiple discharges from the same individual in an analytic sample could lead to biased estimates. We limited this bias by restricting our analysis sample to only discharges with no prior admissions in their lifetime; however, exclusion of discharges with multiple episodes of treatment should be acknowledged as an important limitation, particularly as those with multiple discharges in a year may represent patients with the highest need. Second, TEDS-D data collection process is based on reports from individual programs across different states. The variables might be defined differently across individual programs. In addition, some states did not report in certain years. For example, data was not available for Georgia (non-expansion state), Oregon (expansion state), and West Virginia (expansion state) from 2015 to 2017, which could potentially affect the generalizability of our estimates. The missing data (for example, 60% of health insurance information is missing) also limited further analysis of the roles of different types of health insurance coverage on referral sources, though such analyses would likely be plagued by endogeneity further highlighting the value of leveraging the exogenous natural experiment of Medicaid expansion via the 2WFE and DID models.

Conclusion

This study found that Medicaid expansion under the ACA had a positive impact on the likelihood of being referred by healthcare providers in outpatient treatment for OUD. Our study findings suggest that Medicaid expansion has the potential to improve the referral system through healthcare provider referrals. Ongoing Medicaid expansion under the ACA should focus on the healthcare provider referral system to improve access to treatments for OUD with appropriate level of care.

Table 2-2. Sample characteristics

Total	Frequency N= 382, 609	Percent %
Referral sources	N=375, 583	
Self-referral	201,632	53.7
Healthcare provider referral	50,465	13.4
Other institutional referral	38,631	10.3
Court/criminal justice referral	84,855	22.6
MAT	N= 375,051	
Yes	133,787	35.7
Frequency of use	N= 369,848	
No use in the past month	106,921	28.9
Some use	71,499	19.3
Daily use	191,428	51.8
Age	N= 382, 609	
18-29	127,141	33.2
30-44	179,390	46.9
45-64	76,078	19.9
Gender	N= 382,525	
Male	209,602	54.8
Race/ethnicity	N= 375,376	
Non-Hispanic White	289,016	77.0
Non-Hispanic Black	31,413	8.4
Hispanic	40,542	10.8
Other	14,405	3.8
Education	372, 826	
Highschool or higher	271,923	72.9
Number of arrests	N= 364, 417	
None	340, 071	
1	19, 430	5.3
2 or more	4, 916	1.4
Employment status	N= 376, 639	
Employed	275, 672	73.2
Comorbidity	N=333, 487	
Yes	103, 207	
Homeless	N= 371, 037	
Yes	20, 687	5.6
Polysubstance use	N= 304, 655	
No	128,782	42.3
One more	104,430	34.3
Two or more	71,443	23.5

Figure 5. Number of discharges by referral sources from 2010-2017 TEDS-D

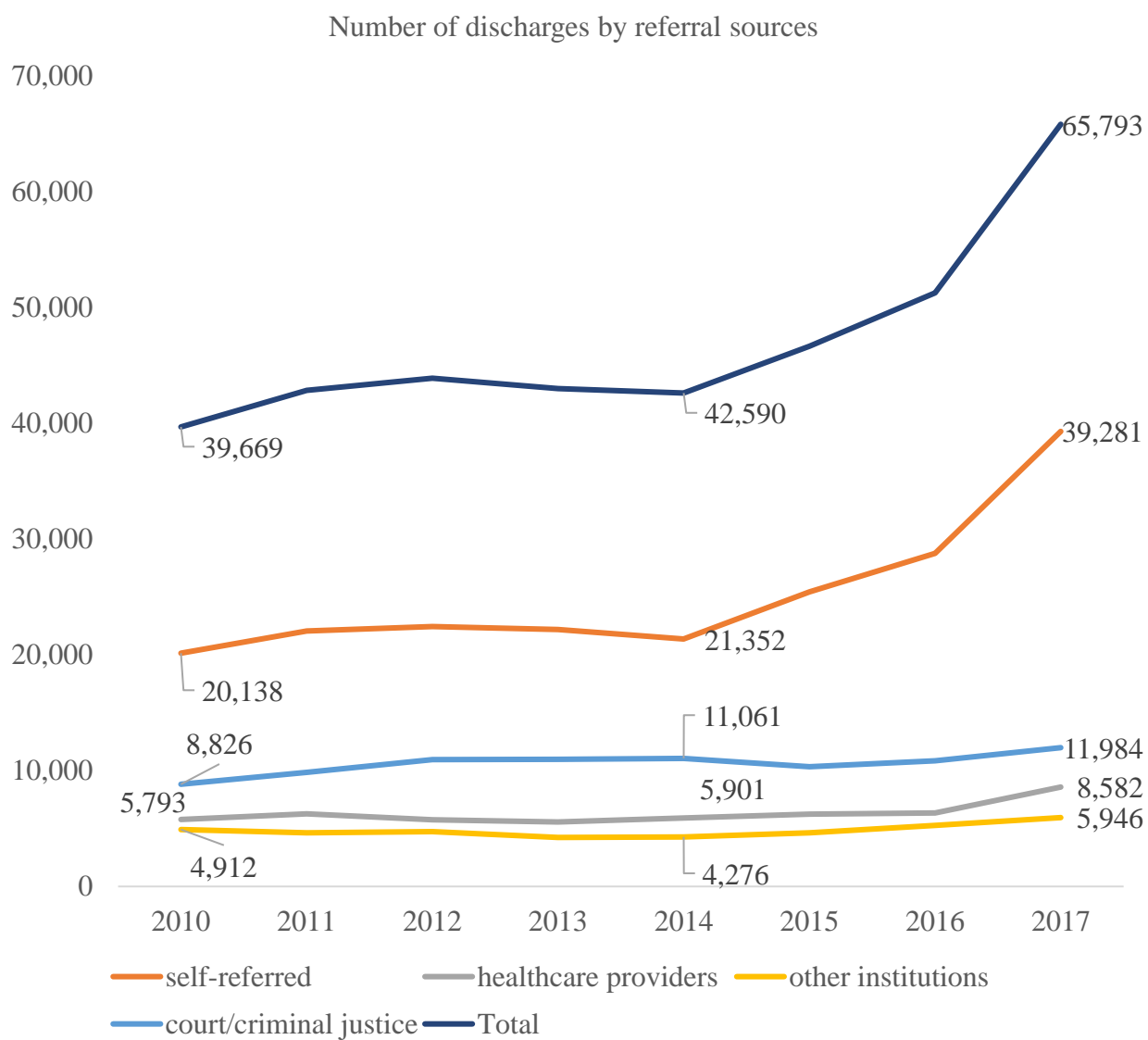


Figure 6. Trends in referral sources across Medicaid expansion and non-expansion states, in non-intensive outpatient opioid treatments, TEDS-D 2010-2017. The vertical line represents the Medicaid expansion under the ACA (2014).

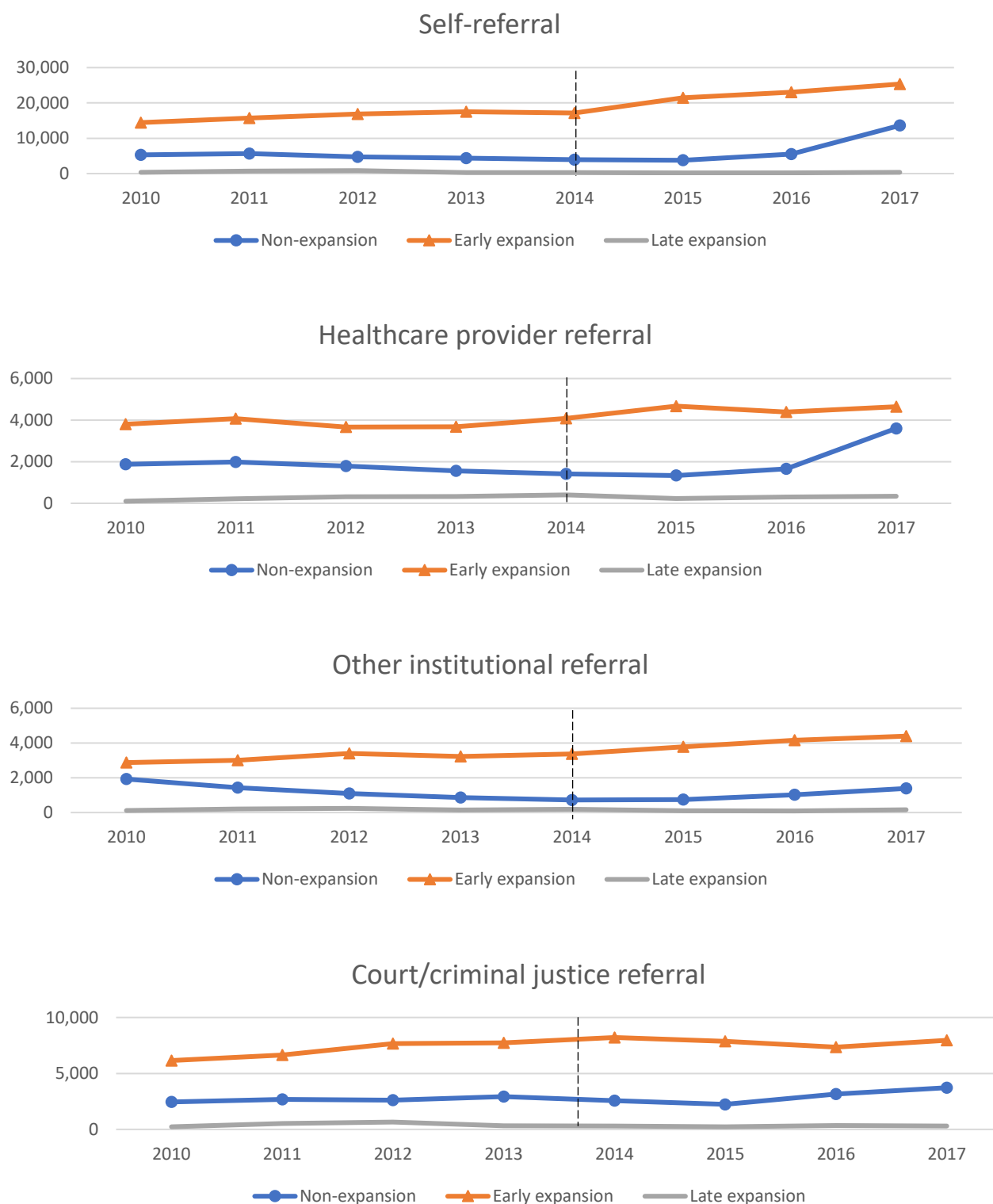


Table 2-3. 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	231,025 RRR (95%CI)	231,025 RRR (95%CI)	231,025 RRR (95%CI)
Medicaid expansion			
Yes	1.18*** (1.11 - 1.24)	2.28*** (2.13 - 2.44)	1.31*** (1.24 - 1.38)
MAT (No= ref)			
Yes	0.64*** (0.62 - 0.66)	0.34*** (0.33 - 0.36)	0.14*** (0.13 - 0.14)
Frequency of use (No past month use= ref)			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.63 - 0.68)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.38)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.01 (0.97 - 1.04)	0.99 (0.97 - 1.02)
45-64	1.11*** (1.07 - 1.15)	0.81*** (0.78 - 0.85)	0.87*** (0.84 - 0.90)
Gender (Female=ref)			
Male	0.88*** (0.86 - 0.90)	0.62*** (0.61 - 0.64)	1.32*** (1.29 - 1.35)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.01 (0.96 - 1.07)	1.35*** (1.27 - 1.44)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.85 - 0.95)	1.30*** (1.23 - 1.37)	1.21*** (1.15 - 1.27)
Other	0.87*** (0.81 - 0.94)	1.03 (0.95 - 1.11)	0.96 (0.90 - 1.03)
Education (Less than high school= ref)			
Highschool or higher	0.96** (0.93 - 0.99)	0.79*** (0.76 - 0.81)	0.77*** (0.75 - 0.79)
Number of arrests (0= ref)			

1	0.85*** (0.80 - 0.91)	1.18*** (1.10 - 1.26)	2.71*** (2.58 - 2.85)
2 or more	0.86** (0.77 - 0.96)	0.96 (0.83 - 1.11)	1.09 (0.99 - 1.20)
Employment status (Not employed= ref)			
Employed	1.32*** (1.28 - 1.36)	1.15*** (1.11 - 1.19)	0.94*** (0.92 - 0.97)
Comorbidity (No= ref)			
Yes	1.48*** (1.44 - 1.52)	0.91*** (0.89 - 0.94)	0.65*** (0.63 - 0.67)
Homeless (No= ref)			
Yes	1.31*** (1.25 - 1.38)	1.37*** (1.29 - 1.45)	0.61*** (0.57 - 0.65)
Polysubstance use (no= ref)			
One more	0.99 (0.96 - 1.02)	1.03 (0.99 - 1.06)	0.85*** (0.83 - 0.88)
Two or more	0.98 (0.95 - 1.01)	1.07*** (1.03 - 1.11)	0.95** (0.92 - 0.98)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix 4-A for the full results).

Table 2-4. DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	RRR	RRR	RRR
	(95% CI)	(95% CI)	(95% CI)
Expansion	0.84	0.94	1.06
	(0.52 - 1.35)	(0.58 - 1.52)	(0.64 - 1.75)
Post expansion	0.70***	0.42***	0.82***
	(0.66 - 0.75)	(0.39 - 0.45)	(0.78 - 0.87)
Expansion * Post expansion	1.18***	2.39***	1.32***
	(1.12 - 1.25)	(2.23 - 2.56)	(1.25 - 1.39)
MAT (No= ref)			
Yes	0.65***	0.34***	0.14***
	(0.63 - 0.67)	(0.32 - 0.35)	(0.13 - 0.14)
Frequency of use			
Some use	0.64***	0.66***	0.39***
	(0.62 - 0.67)	(0.64 - 0.69)	(0.37 - 0.40)
Daily use	0.51***	0.38***	0.16***
	(0.50 - 0.53)	(0.36 - 0.39)	(0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00	1.00	0.99
	(0.97 - 1.03)	(0.97 - 1.03)	(0.97 - 1.02)
45-64	1.11***	0.81***	0.87***
	(1.07 - 1.15)	(0.77 - 0.85)	(0.84 - 0.90)
Gender			
Male	0.88***	0.62***	1.32***
	(0.86 - 0.90)	(0.60 - 0.64)	(1.29 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02	1.36***	1.19***
	(0.96 - 1.07)	(1.28 - 1.45)	(1.13 - 1.26)
Hispanic	0.89***	1.31***	1.21***
	(0.85 - 0.94)	(1.24 - 1.39)	(1.15 - 1.27)
Other	0.88***	1.04	0.98
	(0.82 - 0.95)	(0.96 - 1.12)	(0.92 - 1.06)
Education			
Highschool or higher	0.96*	0.81***	0.78***
	(0.94 - 0.99)	(0.78 - 0.84)	(0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83***	1.20***	2.73***
	(0.78 - 0.89)	(1.12 - 1.28)	(2.60 - 2.87)
2 or more	0.86*	0.96	1.08
	(0.77 - 0.97)	(0.83 - 1.12)	(0.98 - 1.20)

Employment status			
Employed	1.33*** (1.29 - 1.37)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity			
Yes	1.50*** (1.46 - 1.54)	0.91*** (0.88 - 0.94)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.26 - 1.40)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	1.00 (0.97 - 1.03)	1.02 (0.98 - 1.05)	0.85*** (0.82 - 0.87)
Two or more	0.99 (0.95 - 1.02)	1.06** (1.02 - 1.10)	0.94*** (0.91 - 0.97)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.
The associations were also adjusted for year and state fixed effects (Please see appendix 4-A for the full results)

Table 2-5. 2WFE model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	169,449	169,449	169,449
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expanded	1.17*** (1.10 - 1.24)	2.36*** (2.19 - 2.54)	1.25*** (1.18 - 1.32)
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.64 - 0.70)	0.67*** (0.64 - 0.70)	0.40*** (0.38 - 0.41)
Daily use	0.59*** (0.57 - 0.61)	0.41*** (0.39 - 0.43)	0.18*** (0.17 - 0.19)
Age (18-29= ref)			
30-44	1.03 (0.99 - 1.06)	1.00 (0.96 - 1.03)	0.98 (0.96 - 1.01)
45-64	1.21*** (1.16 - 1.27)	0.82*** (0.78 - 0.86)	0.91*** (0.88 - 0.95)
Gender (Female=ref)			
Male	0.91*** (0.88 - 0.93)	0.60*** (0.58 - 0.62)	1.33*** (1.29 - 1.36)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.14*** (1.07 - 1.22)	1.56*** (1.45 - 1.67)	1.30*** (1.23 - 1.37)
Hispanic	1.02 (0.95 - 1.09)	1.55*** (1.45 - 1.66)	1.33*** (1.26 - 1.41)
Other	0.90* (0.82 - 0.98)	1.05 (0.96 - 1.14)	0.97 (0.90 - 1.04)
Education (Less than high school= ref)			
Highschool or higher	0.94*** (0.91 - 0.97)	0.76*** (0.74 - 0.79)	0.75*** (0.73 - 0.77)
Number of arrests (0= ref)			

1	0.79*** (0.73 - 0.85)	1.13** (1.05 - 1.22)	2.48*** (2.36 - 2.62)
2 or more	0.69*** (0.61 - 0.78)	0.93 (0.79 - 1.09)	0.93 (0.84 - 1.04)
Employment status (Not employed= ref)			
Employed	1.30*** (1.25 - 1.35)	1.12*** (1.08 - 1.16)	0.92*** (0.90 - 0.95)
Comorbidity (No= ref)			
Yes	1.57*** (1.52 - 1.62)	0.85*** (0.82 - 0.88)	0.62*** (0.60 - 0.64)
Homeless (No= ref)			
Yes	1.31*** (1.23 - 1.39)	1.25*** (1.16 - 1.33)	0.57*** (0.53 - 0.61)
Polysubstance use (no= ref)			
One more	0.99 (0.95 - 1.02)	0.92*** (0.89 - 0.96)	0.78*** (0.76 - 0.81)
Two or more	0.91*** (0.88 - 0.95)	0.93*** (0.89 - 0.97)	0.84*** (0.82 - 0.87)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix 4-A for the full results)

Table 2-6. 2WFE model for the associations among MAT, non-intensive outpatient treatment for OUD: logit models

	Healthcare provider referral	Court/criminal justice referral
N	53,295	48,302
	AOR (95%CI)	AOR (95%CI)
Medicaid expansion		
Expanded	1.10 (0.97 - 1.25)	1.31 (1.00 - 1.71)
Frequency of use (No past month use= ref)		
Some use	0.58*** (0.53 - 0.63)	0.36*** (0.32 - 0.40)
Daily use	0.38*** (0.36 - 0.41)	0.15*** (0.13 - 0.16)
Age (18-29= ref)		
30-44	0.91** (0.86 - 0.96)	0.99 (0.91 - 1.08)
45-64	0.86*** (0.80 - 0.93)	0.58*** (0.51 - 0.66)
Gender (Female=ref)		
Male	0.81*** (0.77 - 0.85)	1.14*** (1.06 - 1.24)
Race/ethnicity (non-Hispanic White=ref)		
Non-Hispanic Black	0.87** (0.79 - 0.95)	0.99 (0.85 - 1.17)
Hispanic	0.81*** (0.73 - 0.89)	0.81** (0.69 - 0.93)
Other	0.83* (0.71 - 0.97)	0.91 (0.71 - 1.15)
Education (Less than high school= ref)		
Highschool or higher	0.97 (0.92 - 1.02)	0.87*** (0.80 - 0.94)
Number of arrests (0= ref)		

1	0.98	5.34***
	(0.86 - 1.13)	(4.69 - 6.08)
2 or more	1.45**	2.01***
	(1.11 - 1.90)	(1.38 - 2.93)
Employment status (Not employed= ref)		
Employed	1.37***	0.98
	(1.29 - 1.46)	(0.90 - 1.07)
Comorbidity (No= ref)		
Yes	1.20***	1.01
	(1.14 - 1.27)	(0.93 - 1.10)
Homeless (No= ref)		
Yes	1.31***	0.82*
	(1.18 - 1.44)	(0.68 - 0.98)
Polysubstance use (no= ref)		
One more	0.93**	1.57***
	(0.88 - 0.98)	(1.43 - 1.72)
Two or more	1.09*	2.23***
	(1.02 - 1.16)	(2.02 - 2.46)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.
The associations were also adjusted for year and state fixed effects (Please see appendix 4-A for the full results)

Table 2-7. DID model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	164,420	164,420	164,420
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Expansion	0.91 (0.41 - 2.01)	0.71 (0.37 - 1.38)	1.14 (0.60 - 2.16)
Post expansion	0.68*** (0.64 - 0.73)	0.34*** (0.32 - 0.37)	0.75*** (0.70 - 0.80)
Expansion * Post expansion	1.18*** (1.10 - 1.25)	2.50*** (2.31 - 2.69)	1.25*** (1.18 - 1.32)
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.64 - 0.70)	0.67*** (0.65 - 0.70)	0.40*** (0.38 - 0.41)
Daily use	0.59*** (0.57 - 0.61)	0.41*** (0.40 - 0.43)	0.18*** (0.17 - 0.19)
Age (18-29= ref)			
30-44	1.02 (0.99 - 1.06)	1.00 (0.96 - 1.03)	0.98 (0.96 - 1.01)
45-64	1.21*** (1.16 - 1.27)	0.82*** (0.78 - 0.86)	0.91*** (0.87 - 0.95)
Gender (Female=ref)			
Male	0.91*** (0.88 - 0.94)	0.59*** (0.57 - 0.61)	1.32*** (1.29 - 1.36)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.16*** (1.08 - 1.23)	1.56*** (1.45 - 1.68)	1.30*** (1.22 - 1.37)
Hispanic	1.02 (0.95 - 1.10)	1.56*** (1.46 - 1.68)	1.34*** (1.26 - 1.42)
Other	0.90* (0.83 - 0.99)	1.06 (0.97 - 1.16)	0.99 (0.92 - 1.07)
Education (Less than high school= ref)			
Highschool or higher	0.94**	0.77***	0.75***

	(0.91 - 0.98)	(0.74 - 0.80)	(0.73 - 0.78)
Number of arrests (0= ref)			
1	0.77*** (0.71 - 0.84)	1.13** (1.05 - 1.22)	2.48*** (2.36 - 2.62)
2 or more	0.71*** (0.62 - 0.80)	0.92 (0.78 - 1.08)	0.92 (0.83 - 1.03)
Employment status (Not employed= ref)			
Employed	1.31*** (1.27 - 1.36)	1.12*** (1.08 - 1.16)	0.92*** (0.90 - 0.95)
Comorbidity (No= ref)			
Yes	1.59*** (1.54 - 1.64)	0.85*** (0.82 - 0.88)	0.62*** (0.60 - 0.64)
Homeless (No= ref)			
Yes	1.34*** (1.26 - 1.42)	1.24*** (1.15 - 1.32)	0.56*** (0.52 - 0.60)
Polysubstance use (no= ref)			
One more	1.00 (0.96 - 1.03)	0.92*** (0.88 - 0.95)	0.78*** (0.75 - 0.80)
Two or more	0.92*** (0.89 - 0.96)	0.93*** (0.89 - 0.96)	0.83*** (0.80 - 0.86)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI. The associations were also adjusted for year and state fixed effects (Please see appendix 4-A for the full results)

Table 2-8. DID model for the associations among MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	60,852	60,852	60,852
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Expansion	0.79 (0.43 - 1.44)	1.17 (0.54 - 2.54)	0.47 (0.18 - 1.18)
Post expansion	0.71*** (0.62 - 0.82)	0.51*** (0.42 - 0.62)	1.18 (0.89 - 1.57)
Expansion * Post expansion	1.12 (0.99 - 1.28)	2.22*** (1.83 - 2.69)	1.33* (1.02 - 1.74)
Frequency of use (No past month use= ref)			
Some use	0.58*** (0.53 - 0.63)	0.69*** (0.62 - 0.76)	0.35*** (0.32 - 0.39)
Daily use	0.38*** (0.35 - 0.41)	0.40*** (0.37 - 0.44)	0.15*** (0.13 - 0.16)
Age (18-29= ref)			
30-44	0.92** (0.87 - 0.98)	0.95 (0.88 - 1.02)	1.02 (0.94 - 1.11)
45-64	0.91* (0.84 - 0.98)	0.69*** (0.62 - 0.77)	0.61*** (0.54 - 0.69)
Gender (Female=ref)			
Male	0.82*** (0.78 - 0.86)	0.73*** (0.68 - 0.78)	1.21*** (1.12 - 1.30)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.88** (0.80 - 0.96)	1.04 (0.91 - 1.19)	0.97 (0.82 - 1.13)
Hispanic	0.82*** (0.74 - 0.90)	0.93 (0.82 - 1.05)	0.80** (0.69 - 0.92)
Other	0.85* (0.73 - 0.99)	1.03 (0.85 - 1.24)	0.93 (0.73 - 1.17)
Education (Less than high school= ref)			
Highschool or higher	0.98	0.91*	0.90*

	(0.93 - 1.03)	(0.85 - 0.98)	(0.83 - 0.98)
Number of arrests (0= ref)			
1	0.99 (0.86 - 1.14)	1.29** (1.09 - 1.52)	5.07*** (4.47 - 5.75)
2 or more	1.44** (1.10 - 1.89)	0.84 (0.53 - 1.32)	2.35*** (1.64 - 3.38)
Employment status (Not employed= ref)			
Employed	1.40*** (1.32 - 1.49)	1.21*** (1.12 - 1.31)	1.00 (0.92 - 1.09)
Comorbidity (No= ref)			
Yes	1.21*** (1.14 - 1.28)	1.26*** (1.18 - 1.35)	1.07 (0.99 - 1.16)
Homeless (No= ref)			
Yes	1.34*** (1.21 - 1.48)	1.62*** (1.44 - 1.82)	0.92 (0.77 - 1.10)
Polysubstance use (no= ref)			
One more	0.93** (0.88 - 0.98)	1.36*** (1.26 - 1.47)	1.59*** (1.46 - 1.74)
Two or more	1.07* (1.00 - 1.14)	1.47*** (1.34 - 1.60)	2.15*** (1.95 - 2.37)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI. The associations were also adjusted for year and state fixed effects (Please see appendix 4-A for the full results)

Table 2-9. Summary table for the adjusted associations between Medicaid expansion and referral sources

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
	RRR (95%CI)	RRR (95%CI)	RRR (95%CI)
Medicaid expansion			
Yes	1.18*** (1.11 - 1.24)	2.28*** (2.13 - 2.44)	1.31*** (1.24 - 1.38)
<i>Among non-MAT</i>			
Medicaid expansion	RRR	RRR	RRR
Yes	1.17*** (1.10 - 1.24)	2.36*** (2.19 - 2.54)	1.25*** (1.18 - 1.32)
<i>Among MAT</i>			
Medicaid expansion	AOR		AOR
Yes	1.10 (0.97 - 1.25)		1.31 (1.00 - 1.71)
<i>Sensitivity analysis with additional covariates</i>			
Medicaid expansion	RRR	RRR	RRR
Yes	1.10** (1.04 - 1.16)	2.11*** (1.97 - 2.27)	1.28*** (1.22 - 1.35)
<i>Sensitivity analysis with added Section 1115 Waiver</i>			
Medicaid expansion	RRR	RRR	RRR
Yes	1.17*** (1.11 - 1.24)	2.26*** (2.11 - 2.42)	1.31*** (1.24 - 1.38)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.
Adjusted Odd Ratio =AOR

Chapter 4 Medicaid expansion's role in opioid use disorder treatment completion and length of stay in outpatient treatment settings

Abstract

Along with expanded access, treatment retention is a key step towards improving long-term opioid use disorder (OUD) treatment outcomes. However, there is a dearth of studies examining associations between Medicaid expansion and OUD treatment outcomes in outpatient treatment settings, which is surprising, given that Medicaid expansion under the ACA has played a significant role in improving the substance use treatment system. This study explores the role of Medicaid expansion in OUD treatment completion and retention in outpatient settings.

This study used a two-way fixed effects (2WFE) model to examine the effect of Medicaid expansion on treatment outcomes. A simple difference-in-differences (DID) model that only included states that expanded Medicaid in 2014 and states that did not expand by 2017 was used as a sensitivity test. Data were 2010-2017 Treatment Episode Data Set- Discharge (TEDS-D) in non-intensive outpatient treatment for OUD (N= 382,609). Logistic regression models controlled for state and year fixed effects, Medication-Assisted Treatment (MAT) for OUD, and other covariates including demographic characteristics, psychiatric comorbidity, and poly substance use were included as covariates. The adjusted associations were stratified by MAT, as non-intensive outpatient treatment could include both MAT and non-MAT, while treatment outcome expectation could be different between these two strategies (e.g., treatment retention is expected as a positive outcome for MAT).

Patients in Medicaid expansion states were less likely to stay in non-intensive outpatient treatment longer than 90 days (AOR 0.9, 95% CI: 0.89-0.97), compared with those in non-expansion states. However, patients from Medicaid expansion states receiving MAT were more likely to stay in non-intensive outpatient treatment for OUD longer than 90 days than those in non-expansion states

(AOR 1.2, 95%; CI: 1.08-1.30). Findings from the 2WFE were consistent with the findings from the DID model.

Our study indicated that Medicaid expansion was positively associated with treatment retention in medication for OUD in outpatient treatment setting, but negatively associated with treatment completion in non-MAT treatment. We suggest a renewed focus on the role of insurance coverage policies such as Medicaid program on treatment retention in opioid treatment. Further research should address state variations in Medicaid policy components for a better understanding of mechanisms of the policy effect on OUD treatment retention and completion.

Introduction

Only one in ten individuals in the U.S. with a substance use disorder (SUD), and only one in five of those with opioid use disorder (OUD) receive any type of treatment.^{1,11} Beyond issues of access, treatment completion is a key step towards improving long-term SUD treatment outcomes (e.g., sustained abstinence/recovery, improved health, social, and economic outcomes^{13,14}). In a study on treatment completion among publicly-funded substance use treatment facilities, only 28% of patients completed their treatment.¹⁴ As a majority of individuals with OUD are low income (more than 60%),¹¹ lack of financial support for these patients to participate and remain in treatment is one key barrier. Other barriers include the limited availability of providers and stigma toward substance use treatment.¹² Further, the ability of the health care delivery system to refer individuals with SUD in need of treatment to appropriate, evidence-based treatments is lacking,¹⁹ which likely influences treatment completion and retention.^{19,20}

Medicaid expansion represents a significant policy shift both because it has increased health insurance coverage for so many individuals with SUD (Medicaid pays for a majority of individuals with SUD³⁵) and because it has increased the supply of treatment providers.²⁴ Thus, Medicaid expansion has been instrumental in reforming the U.S. delivery system for SUD treatment and increasing access to such treatment.⁶⁶ By enabling states to expand Medicaid eligibility to low-income adults up to 138% of FPL⁸¹ Medicaid expansion under the Patient Protection Affordable Care Act (ACA) has increased insurance coverage among individuals with SUD in 37 states as of 2020.⁸² Importantly, the ACA also defined SUD as one of ten essential health benefits that must be covered and should be covered on parity with other medical conditions;⁶⁷ however, this benefit can vary by state as the ACA did not specify which SUD services must be included. Prior to the ACA, most low-income people who were in need of medication assisted treatment were left untreated.⁸³ However, the evidence suggests that Medicaid

expansion has narrowed the treatment gap through increased insurance coverage and delivery system changes.^{84,85} Indeed, previous studies found that Medicaid expansion has helped reduce the percentage of uninsured low-income adults with SUD from 36% to 27%.^{21,22} Additionally, admissions to SUD treatment among Medicaid beneficiaries increased 113% as a result of expansion, without crowding out admissions from individuals with other types of insurance.²³ Medicaid expansion has also resulted in substantial increases in the use of pharmacological therapy, including methadone and buprenorphine, for OUD.^{22–24}

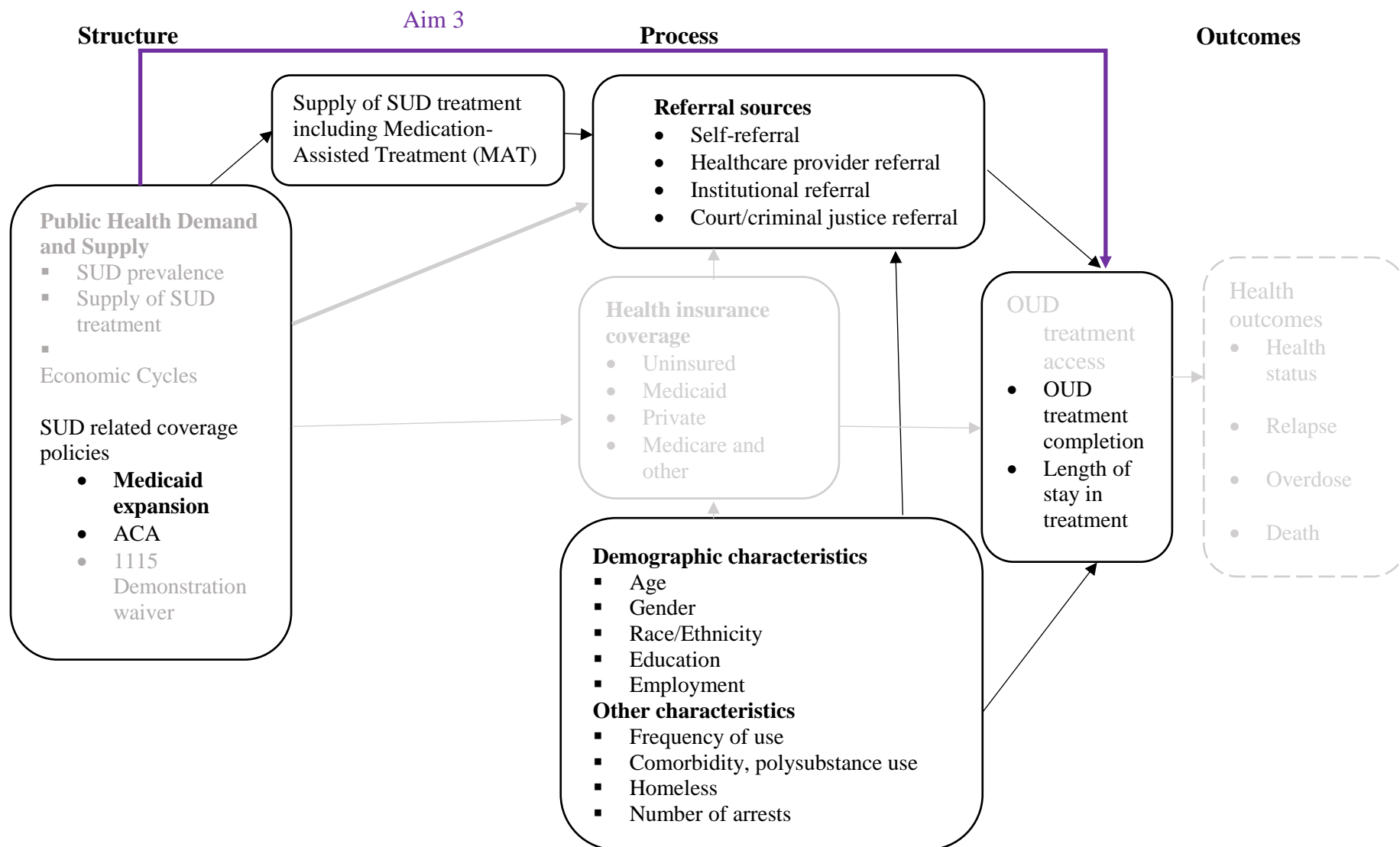
Although there have been many interpretations of how best to define treatment success, treatment completion and treatment retention are considered key indicators for positive treatment outcomes for substance use treatment.^{13,14} Brorson and co-authors asserted that treatment completion is one of the most widely used proximal measures of SUD treatment effectiveness.¹³ In their study, treatment completion was defined as successfully completing treatment goals. The authors particularly pointed out that individuals who completed substance use treatment were more likely to remain abstinent, had fewer relapses, and were in better health.¹³ In addition, previous studies only focused on substance treatment completion in general, whereas opioid treatment completion could be different. There has been a shift from rapid detoxification to long-term treatment for OUD given that OUD has been considered a chronic disease.^{106–108} Medication-assisted treatment (MAT) for OUD — methadone, buprenorphine, and naltrexone — have been approved by the Food and Drug Administration to be effective in reducing drug use and overdose.¹⁰⁹ Evidence also indicated that longer stay in MAT led to better outcomes. Indeed, the NIDA Clinical Trials Network on opioid treatment over time indicated that long-term MAT for recovery is considered best practice.¹⁰⁸

Medicaid expansion under the ACA has played the significant role in SUD treatment delivery and care reform; however, most of the previous studies on Medicaid expansion have focused on its

associations with substance use treatment access instead of substance use treatment completion and retention. No study has examined the relationship between Medicaid expansion and outpatient treatment for OUD. Furthermore, previous studies used data collected before the ACA implementation in 2014, which did not capture post ACA and Medicaid policies that facilitated improving access to SUD treatments. To fill this critical knowledge gap, this study explored the role of Medicaid expansion in OUD treatment outcomes, including both treatment completion and length of stay in the treatment.

Conceptual model

Figure 7. Conceptual model of Medicaid expansion, referral source, and OUD treatment access and outcomes



The conceptual model above was adapted from the Donabedian framework that describes the associations of structure, process, and outcomes in the healthcare system (figure 1).⁸⁷ “Structure” includes substance use related coverage policies (e.g., Medicaid expansion, ACA, 1115 Demonstration Waivers). A referral source is considered a “process” that is influenced by structural factors such as Medicaid expansion. The “structure” and “process” influence outcomes including OUD treatment access and utilization. Based on the conceptual model, the Medicaid expansion under the ACA should improve positive OUD treatment outcomes, including treatment completion, and retention in MAT (e.g., buprenorphine, methadone).

Study aims and hypotheses

Aim 3.1

To examine associations between Medicaid expansion and OUD treatment completion

Hypothesis

Medicaid expansion increases the likelihood of completing OUD treatment in expansion states compared to non-expansion states.

Aim 3.2.

To examine associations between Medicaid expansion and OUD length of stay in the treatment.

Hypothesis

Medicaid expansion increases the likelihood of longer stays in non-intensive outpatient treatment for OUD in expansion states compared to non-expansion states.

Methods

Overview of design and data

This study used a quasi-experimental difference-in-differences (DID) with two-way fixed effects (2WFE) to explore the relationships between Medicaid expansion and treatment completion and

retention.^{21,24} Data were obtained from the publicly available TEDS-D, a national data system of annual discharges from publicly funded substance treatment facilities. They included the following types of facilities and services: (1) 24 hour per day medical acute care services in hospital settings, (2) 24 hour per day services in non-hospital settings, (3) rehabilitation in hospital settings, (4) short-term residential rehabilitation, (5) long term residential rehabilitation, (6) intensive outpatient/ambulatory care, (7) non-intensive outpatient/ambulatory care, and (8) outpatient/ambulatory detoxification.

The TEDS-D surveys were conducted by both the federal government and state agencies to collect information on SUD treatment programs, providing detailed information on the demographic characteristics of those who accessed treatment including their age, gender, race/ethnicity, education, and employment; information on drug use history, MAT (e.g., the use of opioid medications such as methadone, buprenorphine, and naltrexone), homeless status, number of arrests, and referral source. TEDS-D had 12 waves of data (from 2006 to 2017, not counting for year 2018, which has just been released), enabling researchers to combine many waves to increase statistical power and policy relevance. This study used 2010-2017 TEDS-D data to assess the impact of Medicaid expansion under the ACA on SUD treatment outcomes. Data from 2010 to 2017 were chosen in order to have four years (2010-2013) of data from before the ACA implementation (2014) and four years (2014-2017) of data from after the implementation.

Sample

This study uses the same analytic sample as study 2 (which was presented in the Chapter 3) - TEDS-D discharges aged 18 to 64 years old, with no prior admission, in ambulatory, non-intensive outpatient treatment for OUD. A description of the sample is included again below for completeness.

OUD population. The OUD population included all discharges from the 2010-2017 TEDS-D whose primary substance use at admission had been opioids. This resulted in the sample of 3,628,633

observations. We first excluded discharges from Puerto Rico ($n = 3,025$) given that the Medicaid expansion operates differently in the territories (e.g., Puerto Rico) as well as the differences between territories and the states in demographic, health status, and economic indicators.⁸⁹ We then limited the sample to discharges aged 18-64 years old because the expanded Medicaid under the ACA was aimed to increase coverage for this specific population with low-income.⁹⁰ This resulted in a sample of 3,502,661 observations. Further, as has been done in previous work,⁹¹ discharges with a prior admission in the past year ($n=2,279,678$) were excluded because each patient could have many discharges but there was no encoded identity of an individual in the TEDS-D. Additionally, as this study focuses on the role of Medicaid expansion on referrals to outpatient OUD treatment, all discharges other than non-intensive outpatient were excluded (i.e., excluding the discharges from 24 hour per day medical acute care services in hospital setting, 24 hour per day services in non-hospital setting; residential rehabilitation in hospital, residential rehabilitation, short-term; residential rehabilitation, long term; ambulatory, intensive outpatient) ($n=792,458$). Further, discharges due to incarceration, or death, or that were missing were also excluded ($n=47,916$). This resulted an analytic sample of 382,609 discharges aged 18-64 years old, with no prior admission in the current year, with non-intensive outpatient treatment for OUD (For a sample flow chart, see Appendix 3-A).

Measures

OUD treatment success (outcomes)

Substance use treatment outcomes included treatment completion and length of stay in the treatment for OUD. First, the treatment completion variable was constructed as a binary variable, receiving the value of 1 if the participant completed the treatment or was transferred to another appropriate treatment, and 0 if the participant dropped out of treatment or terminated by the facility.

As opioid dependence is increasingly considered to be a chronic disease that could be successfully managed with evidence-based, effective pharmacological treatment,⁸ the length of treatment is also a measure of treatment success.⁸ For this study, length of stay in the opioid treatment was constructed as a binary variable, receiving the value of 1 if length of stay was equal to or greater than 90 days and 0 if length of stay was less than 90 days.⁹¹

Medicaid expansion (Structure)

As is described in more detail below, the effect of Medicaid expansion on the treatment outcomes in outpatient OUD treatment was tested with two different empirical approaches – a two-way fixed effects (2WFE) model and a difference-in-difference (DID). Each of these approaches necessitates a slightly different empirical definition of the Medicaid expansion policy variables. For the two-ways fixed effects model, the key independent variable of interest is defined as whether the state implemented Medicaid expansion under the ACA in a given survey year. For each survey year, we constructed a binary variable receiving the value of 1 if discharges are from states that adopted Medicaid expansion in that year, and 0 if a discharge was from a state that did not expand Medicaid in that year. As of 2017, 31 states and the District of Columbia had expanded Medicaid of which 27 states and the District of Columbia had expanded Medicaid in 2014 (*early expansion*) and 5 states had expanded after 2014 (*late expansion*) (See Appendix Table 1 for summary of Medicaid expansion).⁹² This approach allows us to assess the impact of Medicaid expansion on treatment outcomes, taking into account the fact that states expanded Medicaid in different years.⁹³

In the second empirical approach, the DID model, the independent variable of interest for DID was the interaction whether the discharge was from a facility located in a state with Medicaid expansion and an indicator for whether the discharge occurred in a year after that state expanded Medicaid. In this

approach, only *early expansion*, those that expanded Medicaid in 2014, were included and compared to states that never expanded Medicaid as of 2017.

Referral source (Process)

This variable was constructed as a four-level categorical variable: self-referral, care provider, other institutional referral, court/criminal justice referral. Self-referral was defined as an individual who referred him/herself to the substance use treatment (52.7%). The healthcare provider referral category (13.2%) combined referrals from alcohol/ drug care providers (4.9%) and other healthcare providers (8.3%). The other institutional referral source category (10.1%) combined referrals from school (0.2%), employers (0.3%), and community services (9.6%). The category court/criminal justice referral/DUI/DWI included discharges who were referred by court or criminal justice (22.2%). About 1.8% discharges are defined as missing/unknown/not collected/invalid and are excluded from the analyses that follow.

Covariates

The associations between Medicaid expansion and treatment outcomes were adjusted for state fixed effects and year fixed effects to capture unobserved state heterogeneity and national secular trends in access to SUD treatment (e.g., the opioid use prevalence).^{21,24} Demographic characteristics that were available in TEDS-D and were also included as covariates included age (18-29, 30-44, 45-64 years old), gender (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, other), education (less than high school, high school or higher), employment status (employed, not employed).

In addition, we controlled for whether patients used MAT (yes/no), frequency of opioid use (no use in the past month, some use, daily use), homeless at the time of admission (yes/no), number of times arrested in the 30 days prior to admission (no, one, two or more), psychiatric comorbidity (i.e., whether

patient had psychiatric problem in addition to their substance use) (yes/no), and polysubstance use (no other substance, one more substance other than opioids, two or more substances other than opioids).^{38,91}

Statistical analysis

We first ran a 2WFE model to examine the impact of Medicaid expansion on treatment outcomes using logit model to account for the fact that the states expanded Medicaid expansion under the ACA in a different year.

$$Y = \beta_0 + \beta_1 \text{Medexp}_{st} + \beta X + S + T + \varepsilon. \quad (1)$$

Where Y_{ist} is the outcome of interest, which is a categorical variable including self-referral, healthcare provider, other institutional referral, court/criminal justice. Medexp_{st} is the independent variable, equals to 1 if discharges were from the states that expanded Medicaid in year t and 0 otherwise, X represents a matrix of individual-level control variables, S_s represents state fixed effects, and T_t represents year fixed effects.

We then restricted the sample to states that adopted Medicaid expansion in 2014 and states that did not adopt Medicaid expansion as of 2017. For estimating associations between Medicaid expansion and the treatment outcomes, we used the standard DID design with state and year fixed effects. We controlled for the state fixed effect in order to account for unobserved state heterogeneity. We controlled the year fixed effect to control for national secular trend in substance use treatment that might be systematically correlated with Medicaid expansion (e.g., substance use prevalence).

$$Y = \beta_0 + \beta_1 \text{Exp}_s + \beta_2 \text{PostExpansion}_t + \beta_3 \text{Exp}_s * \text{PostExpansion}_t + \beta X + S + T + \varepsilon. \quad (2)$$

Where Y is the outcome of interest, including treatment completion and length of stay, Exp_s is the independent variable, equal to 1 if the discharges were from the early expansion states and 0 otherwise; PostExpansion_t is a binary variable indicating the period after the early Medicaid expansion (year

2014); $\text{Exp}_{\text{st}} * \text{PostExpansion}_{\text{st}}$ is the interaction of Medicaid expansion and PostExpansion, with X representing a matrix of individual-level control variables, S denoting state fixed effects, and T denoting year fixed effects.

Sensitivity analyses

To identify the effect of Medicaid expansion on treatment outcomes, the DID design has several assumptions that should be met.⁹⁴ Particularly, if the comparison groups have different trends in the outcome of interest prior to the policy change, then the DID design is not necessarily an appropriate design as it violates the parallel trend assumption that may lead to biased estimate of causal effect. To mitigate this concern, we included multiple waves of data in the pre-expansion period (2010-2013), which allowed us to test the parallel trend assumption.⁹⁵ The assumption of DID approach is that the rate of our outcomes among the expansion and non-expansion groups is parallel in the time prior the expansion implementation date, which is the Medicaid expansion under the ACA or the year 2014. We tested the assumption by assessing interactions of expansion status and year variable in the pre-expansion period, we created line graphs to visualize the outcomes of interest (i.e., treatment completion and length of stay) over time. Furthermore, in order to correct for the within serial correlation in a difference in differences context, we clustered the standard errors at the state level.

We ran a sensitivity analysis of the associations stratified by MAT given that non-intensive outpatient treatments service setting may include MAT and non-MAT (e.g., individual, family and/or group services) and that expectation on treatment outcomes from MAT may be different with non-MAT. For example, we would expect longer stay in MAT for better recovery outcomes.^{39,108} In addition, from paper 2 findings, Medicaid expansion was significantly associated with referral sources and that referral source might not be controlled in the associations¹¹⁰ between Medicaid expansion and treatment

completion and length of stay. We conducted another sensitivity analysis that removing referral source variable in the adjusted associations using DID model.

In addition, the association was also adjusted for variables directly affecting substance market at state level including prescription drug monitoring program (PDMP) implementation, and economic conditions including unemployment rates for each state, which were obtained from the Bureau of Labor Statistics' Local Area Unemployment Statistics. We collected effective dates of PDMP implementation and verify via different sources including PDMP websites, the Prescription Drug Abuse Policy System. We conducted sensitivity analysis to estimate the associations and account for the economic conditions and prescription drug monitoring program implementation.

Further, given that the Section 1115 Demonstration waivers also play a significant role in improving SUD delivery system and coverage,²¹ we also checked the robustness of the main finding by including indicator variables states with Section 1115 waivers in a given survey year. We also checked the robustness of the main findings by re-estimating the association by including one-year lag after Medicaid expansion.

Results

Sample characteristics

Table 3-1 shows characteristics of discharges from non-intensive outpatient treatment for opioids from 2010 to 2017, TEDS-D (N= 382,609). About 52% of those with OUD completed the treatment. About 44% of those with OUD stayed in the treatment longer than 90 days. Most discharges were self-referred (more than 50%), followed by referrals from court/criminal justice (23%), healthcare providers (13%). More than one-third of the discharges included medication assisted treatment. More than half of the discharges used opioids daily before participating in treatment. With regards to demographic

characteristics, a majority of the discharges were 30-44 years old, male, non-Hispanic White, with high school completion or higher, had never been arrested, and were employed. About one-third suffered from a comorbid condition. More than half used at least one more substance besides the primary substance (i.e., opioids).

Trends in OUD treatment outcomes across Medicaid expansion states versus non-expansion states

Figures 8 and 9 shows line graphs presenting trends in treatment outcomes across non-expansion, early expansion, and late expansion states from 2010 to 2017, with the vertical lines representing ACA implementation in 2014. The line graphs were created to inspect the parallel trends assumption for the DID model. Figure 8 presents trends in treatment length of stay in non-intensive outpatient treatment for opioids for Medicaid expansion states versus non-expansion states. Before the ACA implementation in 2014, trends in length of stay were increasing in non-expansion states and decreasing in expansion states. After the ACA implementation, there was an increase in length of stay in expansion states, but a decrease in non-expansion states. For late expansion states, the trend in length of stay varied before the ACA implementation and decreased after the ACA implementation. The trend in treatment outcomes for late expansion states seemed to violate the parallel trends assumption.

Figure 9 presents trends in treatment completion in non-intensive outpatient treatment for opioids for Medicaid expansion states versus non-expansion states. Before ACA implementation in 2014, trends in treatment completion were decreasing in non-expansion states and increasing in early expansion states. After ACA implementation, there was an increase in treatment completion in early expansion states and non-expansion states. For late expansion states, the trend in treatment completion fluctuated before ACA implementation and increased slightly after the implementation.

Adjusted associations of Medicaid expansion and treatment length of stay

Table 3-2 presents the adjusted estimates from the two-way fixed effects model and stratified by MAT, using adjusted logistic regressions for associations between Medicaid expansion and treatment length of stay. Compared with those in non-expansion states, discharges from Medicaid expansion states were less likely to stay in non-intensive outpatient treatment longer than 90 days (AOR 0.9, 95% CI: 0.89-0.97). Non-MAT discharges from Medicaid expansion states were also less likely to stay in treatment longer than 90 days compared to those in non-expansion states (AOR 0.9, 95% CI: 0.88-0.97). However, outpatient discharges on MAT in Medicaid expansion states were more likely to stay in treatment longer than 90 days, compared to non-expansion states (AOR 1.2, 95% CI: 1.08-1.30). These results were consistent with the results from the standard DID model that presents the adjusted estimates and stratified by MAT, using adjusted logistic regressions for associations between Medicaid expansion and treatment length of stay (Table 3-3).

Sensitivity analysis results for the adjusted associations of Medicaid expansion and treatment length of stay

Table 3-C1 presents the adjusted estimates from the sensitivity analysis using a DID model in which we removed the referral source covariate since Medicaid expansion was expected to influence referrals to SUD treatment (findings from Chapter 3). After the covariate was removed, we found that those discharges who received MAT in Medicaid expansion states were more likely to stay in opioid treatment longer than 90 days compared to those in non-expansion states (AOR 1.2, 95% CI: 1.1-1.3), which was also consistent with the main DID model.

Table 3-D1 presents results from the sensitivity analysis in which annual state unemployment

rates and state PDMP covariates were added to the 2WFE model. The results were consistent with the main 2WFE in that those who were discharged and received MAT in Medicaid expansion states were more likely to stay in non-intensive outpatient opioid treatment longer than 90 days (AOR 1.2, 95% CI: 1.1-1.3). Similarly, the results of the sensitivity analysis with the additional unemployment and PDMP covariates were consistent with the main DID model results (Table 3-D2).

Table 3-E2 presents the results from the sensitivity analysis with lagged expansion effects in the DID model. Medicaid expansion started to have its positive effect on the opioid treatment length of stay (i.e., longer than 90 days) in year 1 for pooled model (AOR 2.5, 95% CI: 2.3-2.7), non-MAT (AOR 3.0, 95% CI: 2.7-3.3), and MAT (AOR 1.5, 95% CI: 1.2-1.8); but not in year 2. A positive expansion effect was observed in year 3 for both the pooled model (AOR 1.3, 95% CI: 1.2-1.4) and MAT only model (AOR 3.6, 95% CI: 3.0-4.2).

Table 3-F1 shows the sensitivity analysis results from the 2WFE model that added indicators for each state for 1115 Demonstration waivers. Again, the results were consistent with the main 2WFE model in that those discharges who received MAT from Medicaid expansion states were more likely to stay longer than 90 days in outpatient opioid treatment, compared to those in non-expansion states (AOR 1.2, 95 % CI: 1.1-1.3).

We also conducted a sensitivity analysis that examined the associations among discharges with more than one treatment episode in their lifetime (Tables 3-G1 and 3-G2) and found that discharges on MAT in Medicaid expansion states were more likely to stay longer than 90 days in outpatient opioid treatment (AOR 1.1, 95% CI: 1.1-1.2) compared to those in non-expansion states.

Adjusted associations of Medicaid expansion and treatment completion

Table 3-4 shows the adjusted estimates from the pooled two-ways fixed effects model and

stratified by MAT, using adjusted logistic regressions for examining associations between Medicaid expansion and treatment completion. The two-way fixed effect model considers the fact that states expanded their Medicaid expansion at different times. The results showed that discharges from Medicaid expansion states were less likely to complete the treatment in non-intensive outpatient treatment compared to those in non-expansion states (AOR 0.8, 95% CI: 0.8-0.9). When stratified by MAT, those discharges from Medicaid expansion states who received MAT were also less likely to complete non-intensive outpatient treatment, compared to discharges on MAT in non-expansion states (AOR 0.5, 95% CI: 0.4-0.5). These results were consistent with the standard DID model that only included early expansion states and non-expansion states (Table 3-5).

Sensitivity analysis results for the adjusted associations of Medicaid expansion and treatment completion

Table 3-C2 presents the adjusted estimates from the sensitivity analysis using the DID model in which we removed the referral source covariate, since Medicaid expansion was also expected to affect referral sources. The results were consistent with the main 2WFE model except that non-MAT discharges in Medicaid expansion states were more likely to complete treatment compared to those in non-expansion states (AOR 1.1, 95 % CI: 1.3-1.5).

Table 3-D3 presents the results from the sensitivity analysis in which annual state unemployment rates and an indicator for states having a PDMP were added to the 2WFE model as covariates. The results were consistent with the main 2WFE, such that those discharged in Medicaid expansion states were less likely to complete non-intensive outpatient opioid treatment in the pooled model (AOR 0.8, 95% CI: 0.8-0.9) and for those who were on MAT model (AOR 0.5, 95% CI: 0.4-0.5). Similarly, the results of the sensitivity analysis with the additional covariates were consistent with the main DID

model results (Table 3-D4).

Table 3-E2 presents the results from the sensitivity analysis with a lagged expansion effect for the DID model. Medicaid expansion seems to have its positive effect on opioid treatment completion in the expansion year (AOR 1.6, 95% CI: 1.5-1.7); however, it has a negative effect on opioid treatment completion one year after expansion (AOR 0.7, 95% CI: 0.6-0.8), two years after expansion (AOR 0.7, 95% CI: 0.6-0.8), and three years after expansion (AOR 0.6, 95% CI: 0.5-0.6).

Table 3-F2 shows the sensitivity analysis results from the 2WFE model that added the 1115 Demonstration waiver indicators for each state in each year. Again, the results were consistent with the main 2WFE model, showing that in the pooled model, those discharges from Medicaid expansion were less likely to complete opioid treatment compared to those in non-expansion states (AOR 0.9, 95 % CI: 0.8-0.9).

We also conducted the sensitivity analysis among those discharges with more than one episode of treatment (Table 3-G3), and found that discharges in Medicaid expansion states were less likely to complete treatment in the pooled model (AOR 0.9, 95 % CI: 0.86-0.92) and MAT (AOR 0.5, 95 % CI: 0.5-0.6) compared to those in non-expansion states; however, discharges who were on non-MAT in Medicaid expansion states were more likely to complete the treatment (AOR 1.1, 95% CI: 1.1-1.2) compared to those in non-expansion states.

Summary of adjusted associations between key covariates and treatment completion and retention

The adjusted estimates from the 2WFE showed young age, male, being non-Hispanic Black, having psychiatric comorbidities, being homeless, and polysubstance use were negatively associated with the likelihood of treatment retention. However, we found that being employed was associated with being less likely to stay longer than 90 days in non-intensive outpatient treatment for OUD and having

higher education was associated with being less likely to stay longer than 90 days in MAT treatment in non-intensive outpatient treatment for OUD. The results were consistent with the results from the DID model. We also found that young age, male, being non-Hispanic Black, and having psychiatric comorbidities were associated with being less likely to complete treatment while having higher education and being employed were associated with being more likely to complete non-intensive outpatient treatment for OUD.

Discussion

This study provides the first empirical evidence of the impact of Medicaid expansions under the ACA on the treatment completion and length of stay in non-intensive outpatient treatments for OUD. We found that the Medicaid expansion under the ACA was positively associated with longer stay in treatment (at least, more than 90 days) for MAT in non-intensive outpatient treatment. On the other hand, we found that the implementation of Medicaid expansion under the ACA was negatively associated with treatment completion in non-intensive outpatient treatment overall and stratified by MAT. The main findings from the 2WFE model were consistent with the findings from the standard DID model that only included non-expansion states and states that expanded the Medicaid in 2014.

Our main study results on the positive association of Medicaid expansion and treatment length of stay were consistent with the sensitivity analysis results that removed the referral source covariate, the sensitivity analysis results that added state-level variables affecting the substance market (i.e., annual unemployment rates and PDMP implementation), and the sensitivity analysis results that added Section 1115 Demonstration waiver. On the other hand, the main result on the negative association of Medicaid expansion and treatment completion was not robust when the referral source covariate was removed, due both to its significant association with Medicaid expansion which was found in Chapter 3, and the fact

the inclusion of the referral source covariate might result in a biased estimate. This sensitivity analysis indicated that Medicaid expansion was negatively associated with treatment completion in the pooled model and among those who used MAT, but positively associated with treatment completion in non-MAT, non-intensive outpatient treatment for opioids. In addition, there might be a more complicated mechanism that affects the association between Medicaid programs and treatment completion in non-intensive outpatient treatment. For example, even though the ACA required Medicaid programs to cover SUD treatment, there have been variations in coverage for individual services among states. For example, many states did not cover methadone or a full range of services needed for better treatment recovery outcomes.¹¹¹ Further research should explore associations of Medicaid expansion policy components for better understanding of Medicaid policy and SUD treatment outcomes.

Our study contributes to the literature in certain ways. First, it adds to the literature on the role of Medicaid expansion in improving the substance use treatment system by increasing access to treatment and suggests some improvements in treatment outcomes for patients on MAT in outpatient settings. Previous studies on Medicaid expansion mostly focused on its role in health insurance coverage, as well as in the supply and utilization of medication for OUD including buprenorphine.^{21,24,96} These studies found that Medicaid expansion had a positive impact on the increased health insurance coverage, especially for those with low-incomes,²¹ as well as the increased provision of medication for OUD such as buprenorphine.²⁴ Our study further demonstrated the positive influence of Medicaid expansion on opioid treatment retention in outpatient settings with MAT. This finding is important, as treatment retention has been considered a positive treatment outcome in medication treatment for OUD.^{39,108}

Our study also adds to the literatures on factors affecting MAT treatment retention, which are of particular importance as OUD has been increasingly considered a chronic disease that requires long-term medication treatment for better health outcomes (e.g., reducing illegal opioid treatment, overdose,

and improving health).^{112,113} Furthermore, there is growing evidence that treatment retention is considered the key quality indicator for OUD treatment.¹⁰⁸ Previous studies on opioid treatment retention indicated factors that were negatively associated with reduced treatment retention including younger age, polysubstance use, being arrested.^{39–41} In addition, Mennis and his colleagues in their studies on outpatient treatment completion for SUD indicated the influence of race/ethnicity on treatment completion.⁹¹ They found that African Americans and Hispanics were more likely to drop out of treatment compared to Whites. Our studies further highlight the role of OUD treatment related policies such as the Medicaid expansion on evidence-based treatment outcomes.

The adjusted estimates from our study were consistent with previous studies with regards to other factors affecting OUD treatment retention. We also found that younger age, male, being non-Hispanic Black, having psychiatric comorbidities, homeless, and previous arrests/incarceration were negatively associated with treatment retention.^{39–41,44} However, our study also showed that discharges with employment, and higher education were less likely to stay in the outpatient OUD treatment longer than 90 days, which is different from the results of previous studies on OUD treatment retention. We emphasize the importance of addressing these factors in tailoring treatment strategies for better outcomes.

Limitations

This study has several limitations. First, we restricted the sample to discharges aged 18 to 64 years old, with no prior admission, and who received ambulatory, non-intensive outpatient treatment for OUD from publicly-funded substance use programs. Therefore, the generalizability of this study may only apply to this specific population. Second, Medicaid expansion might change the likelihood that SUD treatment facilities reported to TEDS-D. Third, we noticed that even though the ACA required Medicaid programs to cover SUD treatment, there were variations across state Medicaid programs in the

specific SUD services covered, including different types and durations of outpatient treatment and medications for OUD.¹¹¹ Lack of coverage for effective OUD medications (e.g., certain state Medicaid programs did not cover for methadone),¹¹¹ as well of the full range SUD services might increase the likelihood patients accessing treatment in inappropriate settings,¹¹⁴ which could result in poor treatment retention.

Other limitations relate to the utilization of TEDS-D to examine the association between Medicaid expansion and the treatment outcomes. First, TEDS-D is discharge-level data instead of patient-level data, which means that one patient could have many discharges in a given year. It may therefore result in biased estimates. We limited this potential bias by restricting our sample to discharges with no prior admissions; however, exclusion of multiple discharges should be acknowledged as an important limitation, particularly as those with multiple discharges in a year may represent patients with highest need. However, as described above, we performed a sensitivity analysis among those with more than one treatment episode. Second, TEDS-D data collection was based on reports from individual programs across different states which may have missing data and variables that were defined differently across different programs. The missing data (for example, 60% of health insurance information is missing) limited further analysis of the roles of different types of health insurance coverage on treatment outcomes, though such analyses would likely be plagued by endogeneity. Third, TEDS-D length of stay variable was encoded categorically for durations over 30 days; therefore, we could only construct length of stay as a binary variable with a threshold of 90 days. This limited the use of linear or count data models in examining the association between Medicaid expansion and length of stay in opioid treatment.

Conclusion

The strength of this study is that the analyses were based on a large national TEDS-D dataset that is representative of publicly funded outpatient treatment settings in the U.S. This study emphasizes the

role of Medicaid expansion in treatment retention (at least, more than 90 days) in MAT, non-intensive outpatient treatment for opioid use disorder. Given that treatment completion is considered a positive treatment outcome, especially in non-intensive outpatient treatments without medications (e.g., psychosocial therapies), the study finding on the negative effect of Medicaid expansion on those treatments need to be addressed. Medicaid policy makers might consider policies facilitating those psychosocial therapies in combination with medications for better treatment outcomes.

Table 3-1. Sample characteristics

	Frequency	Percent
Total	N= 382,609	%
Treatment completion	N=271,306	
Completed	(187, 837)	51.9
Length of stay	N= 382,609	
90 days or more	166, 533	43.5
Referral sources	N=375, 583	
Self-referral	201,632	53.7
Healthcare provider referral	50,465	13.4
Other institutional referral	38,631	10.3
Court/criminal justice referral	84,855	22.6
MAT	N= 375,051	
Yes	133,787	35.7
Frequency of use	N= 369,848	
No use in the past month	106,921	28.9
Some use	71,499	19.3
Daily use	191,428	51.8
Age	N= 382, 609	
18-29	127,141	33.2
30-44	179,390	46.9
45-64	76,078	19.9
Gender	N= 382,525	
Male	209,602	54.8
Race/ethnicity	N= 375,376	
Non-Hispanic White	289,016	77.0
Non-Hispanic Black	31,413	8.4
Hispanic	40,542	10.8
Other	14,405	3.8
Education	372, 826	
Highschool or higher	271,923	72.9
Number of arrests	N= 364, 417	
None	340, 071	93.3
1	19, 430	5.3

2 or more	4, 916	1.4
Employment status	N= 376, 639	
Employed	275, 672	73.2
Comorbidity	N=333, 487	
Yes	103, 207	30.9
Homeless	N= 371, 037	
Yes	20, 687	5.6
Polysubstance use	N= 304, 655	
No	128,782	42.3
One more	104,430	34.3
Two or more	71,443	23.5

Figure 8. Trends in length of stay across Medicaid expansion and non-expansion states, in non-intensive outpatient opioid treatments, TEDS-D 2010-2017. The vertical line represents the Medicaid expansion under the ACA (2014)

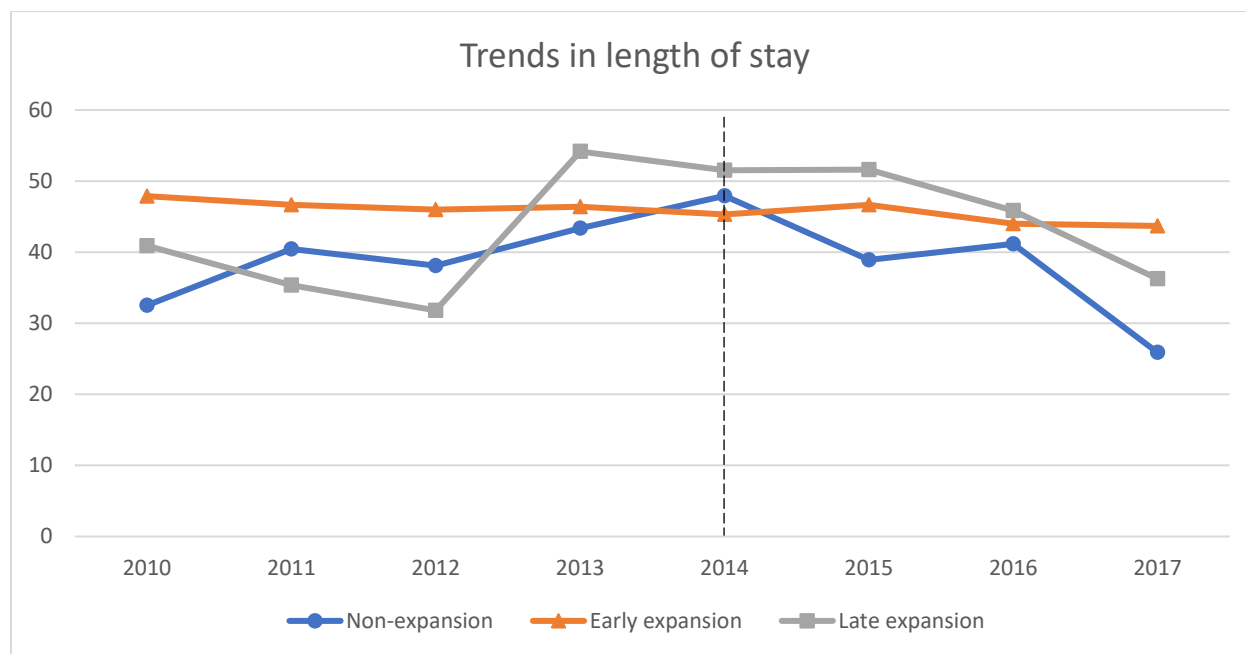


Figure 9. Trends in treatment completion across Medicaid expansion and non-expansion states, in non-intensive outpatient opioid treatments, TEDS-D 2010-2017. The vertical line represents the Medicaid expansion under the ACA (2014)

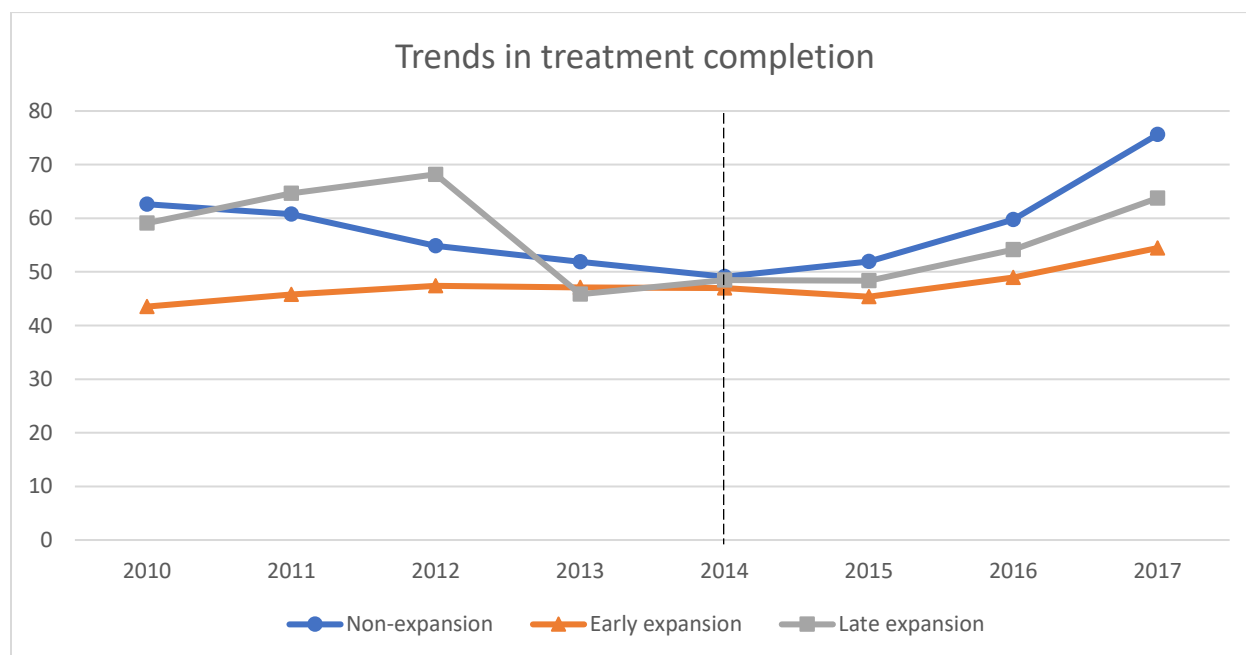


Table 3-2. 2WFE model for the adjusted associations between Medicaid expansion and length of stay

	2 ways fixed effect pooled model	2 ways fixed effect Non-MAT	2 ways fixed effect MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.93*** (0.89 - 0.97)	0.92** (0.88 - 0.97)	1.19*** (1.08 - 1.30)
MAT (No= ref)			
Yes	2.22*** (2.16 - 2.27)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.04)	0.87*** (0.83 - 0.92)
Institutional referral	1.04* (1.01 - 1.08)	1.21*** (1.17 - 1.26)	0.78*** (0.72 - 0.84)
Court/criminal justice	1.87*** (1.82 - 1.92)	2.14*** (2.07 - 2.20)	0.74*** (0.69 - 0.81)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.70 - 0.74)	0.70*** (0.68 - 0.73)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.80 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.04 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.31*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.31*** (1.25 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.91)	0.89*** (0.87 - 0.91)	0.92*** (0.89 - 0.95)
Race/ethnicity (non-Hispanic White=ref)			

Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94** (0.89 - 0.98)	0.93* (0.87 - 0.98)
Hispanic	1.01 (0.98 - 1.05)	0.94* (0.90 - 0.99)	1.09** (1.03 - 1.16)
Other	1.00 (0.95 - 1.06)	1.00 (0.94 - 1.06)	0.99 (0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.97 (0.93 - 1.01)	1.04 (0.99 - 1.09)	0.79*** (0.73 - 0.86)
2 or more	1.18*** (1.09 - 1.28)	1.17*** (1.07 - 1.27)	0.88 (0.73 - 1.06)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.90*** (0.87 - 0.92)	0.89*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.74*** (0.70 - 0.77)	0.77*** (0.73 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.80*** (0.78 - 0.81)	0.80*** (0.78 - 0.82)	0.86*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.74)	0.76*** (0.73 - 0.78)	0.76*** (0.72 - 0.80)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

The associations were also adjusted for year and state fixed effects (Please see appendix 4-B for the full results).

Table 3-3. DID model for the adjusted associations between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,272	164,420	60,849
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat	2.91***	2.09**	3.25***
Expansion states	(2.07 - 4.10)	(1.26 - 3.46)	(2.05 - 5.15)
Expansion	0.97	1.33***	0.51***
After the ACA implementation (2014)	(0.93 - 1.02)	(1.26 - 1.41)	(0.46 - 0.56)
Medicaid expansion	0.94**	0.94**	1.19***
Medicaid expansion	(0.90 - 0.98)	(0.89 - 0.98)	(1.08 - 1.31)
MAT (No= ref)	2.23***		
Yes	(2.18 - 2.29)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.05)	0.88*** (0.83 - 0.92)
Institutional referral	1.05** (1.02 - 1.09)	1.22*** (1.17 - 1.26)	0.79*** (0.74 - 0.85)
Court/criminal justice	1.88*** (1.83 - 1.94)	2.16*** (2.10 - 2.23)	0.74*** (0.68 - 0.80)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.69 - 0.74)	0.70*** (0.68 - 0.72)	0.84*** (0.78 - 0.90)
Daily use	0.67*** (0.65 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.79 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.10)	1.07*** (1.05 - 1.10)	1.09*** (1.04 - 1.14)
45-64	1.30*** (1.27 - 1.34)	1.32*** (1.27 - 1.37)	1.31*** (1.24 - 1.38)
Gender (Female=ref)			
Male	0.90***	0.89***	0.93***

	(0.88 - 0.92)	(0.87 - 0.92)	(0.89 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94* (0.89 - 0.99)	0.93* (0.87 - 0.99)
Hispanic	1.01 (0.97 - 1.05)	0.94** (0.89 - 0.98)	1.09** (1.02 - 1.16)
Other	1.01 (0.96 - 1.07)	1.01 (0.94 - 1.08)	0.99 (0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.96 (0.92 - 1.00)	1.04 (0.99 - 1.09)	0.79*** (0.72 - 0.86)
2 or more	1.20*** (1.11 - 1.30)	1.18*** (1.08 - 1.30)	0.88 (0.73 - 1.06)
Employment status (Unemployed= ref)			
Employed	0.80*** (0.78 - 0.82)	0.79*** (0.77 - 0.81)	0.84*** (0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.89*** (0.87 - 0.92)	0.89*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.73*** (0.70 - 0.76)	0.76*** (0.72 - 0.81)	0.70*** (0.64 - 0.75)
Polysubstance use (no= ref)			
One more	0.79*** (0.77 - 0.81)	0.79*** (0.77 - 0.81)	0.85*** (0.82 - 0.89)
Two or more	0.72*** (0.70 - 0.74)	0.75*** (0.73 - 0.77)	0.76*** (0.73 - 0.80)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

The associations were also adjusted for year and state fixed effects (Please see appendix 4-B for the full results).

Table 3-4. 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	231,021	169,447	61,571
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion	0.84***	1.02	0.48***
Expansion	(0.80 - 0.87)	(0.97 - 1.06)	(0.43 - 0.54)
MAT (No= ref)			
Yes	0.86*** (0.84 - 0.88)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.14*** (1.08 - 1.21)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.15*** (1.07 - 1.24)
Court/criminal justice	2.03*** (1.98 - 2.09)	2.00*** (1.94 - 2.06)	1.89*** (1.73 - 2.06)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.71 - 0.76)	0.76*** (0.73 - 0.78)	0.70*** (0.65 - 0.76)
Daily use	0.77*** (0.75 - 0.79)	0.85*** (0.83 - 0.88)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.08)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	0.99 (0.93 - 1.05)
Gender (Female=ref)			
Male	0.93*** (0.92 - 0.95)	0.97** (0.95 - 0.99)	0.81*** (0.78 - 0.84)

Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.82*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.89)	0.92*** (0.88 - 0.97)	0.81*** (0.75 - 0.86)
Other	0.73*** (0.69 - 0.77)	0.76*** (0.72 - 0.81)	0.69*** (0.61 - 0.78)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.19*** (1.13 - 1.24)	1.04 (0.94 - 1.14)
2 or more	0.84*** (0.78 - 0.91)	0.89* (0.81 - 0.97)	1.03 (0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.03 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.88 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.10*** (1.06 - 1.15)	1.14*** (1.08 - 1.20)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.12*** (1.10 - 1.14)	1.13*** (1.11 - 1.16)	1.02 (0.98 - 1.07)
Two or more	1.21*** (1.18 - 1.24)	1.22*** (1.18 - 1.25)	1.07* (1.01 - 1.13)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

The associations were also adjusted for year and state fixed effects (Please see appendix 4-B for the full results).

Table 3-5. DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,268	164,418	60,847
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	1.58*** (1.51 - 1.65)	1.45*** (1.38 - 1.52)	2.12*** (1.89 - 2.39)
Expansion			
After the ACA implementation (2014)	2.00*** (1.42 - 2.82)	1.78* (1.09 - 2.91)	3.01*** (1.85 - 4.91)
Medicaid expansion			
Expansion	0.83*** (0.80 - 0.87)	1.02 (0.97 - 1.07)	0.48*** (0.43 - 0.54)
MAT (No= ref)			
Yes	0.87*** (0.85 - 0.89)		
Referral sources			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.06*** (1.02 - 1.09)	1.15*** (1.09 - 1.22)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.16*** (1.07 - 1.25)
Court/criminal justice	2.05*** (2.00 - 2.11)	2.03*** (1.97 - 2.09)	1.89*** (1.73 - 2.07)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.72 - 0.76)	0.77*** (0.74 - 0.79)	0.70*** (0.65 - 0.75)
Daily use	0.79*** (0.77 - 0.81)	0.87*** (0.85 - 0.90)	0.58*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.08)	1.07*** (1.04 - 1.09)	1.03 (0.98 - 1.08)
45-64	1.11*** (1.08 - 1.14)	1.22*** (1.18 - 1.27)	0.91** (0.86 - 0.96)
Gender (Female=ref)			
Male	0.92*** (0.90 - 0.94)	0.96*** (0.94 - 0.98)	0.80*** (0.77 - 0.84)

Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.82*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.88)	0.92** (0.88 - 0.97)	0.80*** (0.75 - 0.86)
Other	0.74*** (0.70 - 0.78)	0.78*** (0.73 - 0.83)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.16*** (1.11 - 1.21)	1.20*** (1.14 - 1.26)	1.03 (0.94 - 1.14)
2 or more	0.84*** (0.77 - 0.91)	0.89* (0.81 - 0.97)	1.04 (0.83 - 1.30)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.04 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.87 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.11*** (1.06 - 1.16)	1.15*** (1.09 - 1.21)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.13*** (1.10 - 1.15)	1.14*** (1.11 - 1.17)	1.02 (0.98 - 1.07)
Two or more	1.22*** (1.19 - 1.25)	1.22*** (1.19 - 1.26)	1.07* (1.01 - 1.13)
2017	-	-	-

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

The associations were also adjusted for year and state fixed effects (Please see appendix 4-B for the full results).

Table 3-6. Summary table for the adjusted associations between Medicaid expansion and length of stay in the outpatient treatment for OUD

	2WFE pooled model	2WFE Non-MAT	2WFE MAT
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Main results			
Medicaid expansion	0.93*** (0.89 - 0.97)	0.92** (0.88 - 0.97)	1.19*** (1.08 - 1.30)
<i>Sensitivity analysis with additional covariates (unemployment rates and PDMP)</i>			
Medicaid expansion	0.94** (0.90 - 0.98)	0.95 (0.91 - 1.00)	1.15** (1.04 - 1.26)
<i>Sensitivity analysis with added Section 1115 Demonstration Waiver</i>			
Medicaid expansion	0.93** (0.90 - 0.98)	0.93** (0.89 - 0.98)	1.15** (1.05 - 1.27)
<i>Sensitivity analysis for one more treatment episode</i>			
Medicaid Expansion	0.96* (0.93 - 1.00)	0.89*** (0.85 - 0.93)	1.11** (1.04 - 1.19)
<i>Sensitivity analysis removing referral source covariate</i>	DID pooled model	DID Non-MAT	DID MAT
Expansion states	2.96*** (2.10 - 4.15)	2.09** (1.27 - 3.45)	3.35*** (2.12 - 5.30)
Post expansion	0.98 (0.93 - 1.02)	1.30*** (1.23 - 1.37)	0.52*** (0.47 - 0.58)
Medicaid expansion	0.96 (0.92 - 1.00)	0.96 (0.92 - 1.01)	1.17*** (1.07 - 1.29)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-7. Summary table for the adjusted associations between Medicaid expansion and treatment completion in the outpatient treatment for OUD

	2WFE pooled model	2WFE Non-MAT	2WFE MAT
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Main results			
Medicaid expansion	0.84*** (0.80 - 0.87)	1.02 (0.97 - 1.06)	0.48*** (0.43 - 0.54)
<i>Sensitivity analysis with additional covariates (unemployment rates and PDMP)</i>			
Medicaid expansion	0.84*** (0.81 - 0.88)	1.03 (0.99 - 1.09)	0.47*** (0.42 - 0.52)
<i>Sensitivity analysis with added Section 1115 Demonstration Waiver</i>			
Medicaid expansion	0.85*** (0.81 - 0.88)	1.02 (0.97 - 1.07)	0.49*** (0.44 - 0.54)
<i>Sensitivity analysis for one more treatment episode</i>			
Medicaid Expansion	0.87*** (0.84 - 0.90)	1.10*** (1.06 - 1.15)	0.52*** (0.48 - 0.55)
<i>Sensitivity analysis removing referral source covariate</i>			
	DID pooled model	DID Non-MAT	DID MAT
Expansion states	2.02*** (1.43 - 2.84)	1.78* (1.09 - 2.91)	3.00*** (1.84 - 4.87)
Expansion	1.56*** (1.50 - 1.64)	1.40*** (1.33 - 1.47)	2.14*** (1.90 - 2.40)
Medicaid expansion	0.87*** (0.83 - 0.91)	1.06* (1.01 - 1.11)	0.49*** (0.44 - 0.55)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Chapter 5 Conclusions and Implications

Despite many policy efforts to increase access to and supply of substance use disorder treatment, only 11% of people with SUD, and nearly 20% of those with OUD accessed SUD treatment. Beyond issues of access, SUD treatment retention is also concerning as 70% of individuals failed to stay in treatment long enough, likely limiting treatment effectiveness. To contribute to the evidence on improving access to care and treatment retention, our studies were conducted to more fully characterize the role of insurance coverage on access to and outcomes of SUD treatment, by using both individual coverage variables and natural experiments arising from state and year variation in Medicaid expansion. These studies also focus on the role of coverage in the SUD treatment referral system, and particularly how coverage relates to healthcare provider referrals to outpatient treatment settings.

Our first study used a representative national survey on drug use and found that Medicaid insurance coverage was positively associated with the use of any SUD treatment in the past year across any SUD, AUD, or OUD populations. Among those who accessed any SUD treatment, we further explored the role of health insurance in the pattern of SUD treatment utilization and found that those with any SUD or any OUD who were covered by Medicaid were more likely to use outpatient treatment, whereas those who were uninsured were more likely to use self-help only as a substitute for outpatient treatment. However, we did not find a statistically significant positive associations between Medicaid insurance and outpatient treatment utilization among those with AUD. This could be due to the significant role that self-help programs, like Alcoholics Anonymous, plays in the treatment for AUD. Our second study used a large national SUD treatment discharge data set to examine the association of Medicaid expansion with healthcare provider referrals to outpatient SUD treatment, given that provider referrals are considered a key factor in timely and effective SUD treatment utilization. We particularly focused on the role of Medicaid expansion in healthcare provider referrals, given the significant role of

the healthcare sector in evidence-based treatment that emphasizes the use of effective medications for OUD. By using a natural experiment to examine the associations of Medicaid expansion and different referral sources that utilized DID and 2WFE approaches, we found that Medicaid expansion was positively associated with the likelihood of being referred by a healthcare provider in outpatient settings of publicly-funded SUD treatment programs. Beyond the issue of access, we again used a national data set of SUD treatment discharges from publicly funded facilities to evaluate the effect of Medicaid expansion on OUD treatment outcomes in outpatient settings. We found a negative association of Medicaid expansion and OUD treatment completion; however, we found a positive association of Medicaid expansion and treatment completion among those who were not on MAT during their outpatient treatment. This might be caused by the variations in the definitions of the treatment completion variable across different states, as well as by a complicated mechanism that Medicaid coverage influenced treatment completion among those with first time treatment experience. Importantly, we found that Medicaid expansion had a positive effect on treatment retention of at least 90 days for those who were on MAT during their outpatient treatment episode.

While one of key advantages of using TEDS-D is that it is the largest national survey of SUD treatment episodes in publicly funded programs, the study findings in papers 2 and 3 should be interpreted with caution. First, TEDS-D only represents about 50% of all SUD treatment discharges nationwide; the omission of privately funded SUD treatment settings might affect the generalizability of our estimates. Another key limitation of using TEDS-D arises from missing data (e.g., 60% missing of health insurance type information). This prevented us from conducting further analysis to better understand mechanisms that Medicaid expansion under the ACA influenced the SUD treatment outcomes as well as the referral source. However, the utilization of 2WFE and DID approaches, coupled

with many sensitivity analyses, confirmed the robustness of our findings, at least for those with OUD and who had their first treatment experience in an outpatient, publicly-funded facility.

Our study findings contribute to the understanding of the role of health insurance coverage in patterns of SUD treatment utilization. The first finding, besides emphasizing the positive role of Medicaid expansion on outpatient treatment access, also suggests that those who were uninsured used self-help only approaches to substitute for outpatient treatment. This finding points to the importance of coverage policies and interventions that target self-help groups to increase access to evidence-based treatments, such as medications for OUD alone or in combination with psychological therapies. Next, given that the healthcare sector should play a significant role in SUD treatment, and healthcare provider referral is increasingly important for timely and effective treatment, our findings suggest a renewed focus in Medicaid policy on healthcare provider referrals as an important link to evidence-based treatment for OUD. While previous studies indicated certain factors affecting treatment retention, our study emphasizes the role of Medicaid coverage in treatment retention particularly for those who were on MAT in outpatient treatment for OUD. On the other hand, our finding that Medicaid expansion was negatively associated with outpatient treatment completion in general suggests more evidence is needed to better understand the mechanisms by which Medicaid coverage expansions influence treatment completion. In summary, this study emphasizes the renewed focus of Medicaid policy on access to, and referrals to, as well as outcomes of SUD treatment. Looking ahead, future work examining the role of insurance coverage in SUD treatment access and outcomes should explore state-level variations in Medicaid policy components (e.g., variations in medication coverage, individual services covered) and SUD treatment access and outcomes.

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Appendices

Appendix 1-A

Table 1-A1. Adjusted associations of any treatment utilization past year and different types of health insurance coverage, controlling for sociodemographic characteristics and interaction of the post ACA and insurance types.

	Any SUD	Any AUD	Any OUD
Sample size	39,130	30,219	3,897
Population size	154,810,987	123,018,127	15,166,167
	Any SUD treatment past year AOR (95%CI)	Any SUD treatment past year AOR (95%CI)	Any SUD treatment past year AOR (95%CI)
Health insurance			
No insurance = reference			
Medicaid	1.98*** (1.62 - 2.43)	1.97*** (1.52 - 2.54)	1.76** (1.20 - 2.59)
Private	0.68*** (0.57 - 0.81)	0.74** (0.60 - 0.92)	1.11 (0.79 - 1.55)
Medicare and others	1.35* (1.00 - 1.82)	1.42* (1.00 - 2.02)	1.54 (0.82 - 2.89)
Age in years			
18-25= reference			
26-34	1.31*** (1.17 - 1.47)	1.18* (1.02 - 1.37)	1.09 (0.87 - 1.37)
35-49	1.51*** (1.35 - 1.70)	1.48*** (1.28 - 1.71)	1.20 (0.93 - 1.54)
50-64	1.49*** (1.22 - 1.81)	1.53*** (1.22 - 1.92)	1.09 (0.70 - 1.70)
Sex			
Female= reference			
Male	1.32*** (1.18 - 1.47)	1.50*** (1.30 - 1.72)	1.22 (0.97 - 1.53)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.67*** (0.57 - 0.79)	0.86 (0.71 - 1.05)	0.75 (0.51 - 1.12)
Hispanic	0.63*** (0.53 - 0.75)	0.72** (0.59 - 0.88)	0.66* (0.47 - 0.95)
Other race/ethnicity	0.75** (0.61 - 0.92)	0.89 (0.71 - 1.13)	0.43*** (0.27 - 0.66)
Education			
High school or less=ref			
High school or more	0.79*** (0.68 - 0.91)	0.71*** (0.59 - 0.85)	1.13 (0.87 - 1.46)

Total annual family income			
< \$50,000= ref			
\$ 50,000-74,999	0.94 (0.81 - 1.10)	0.99 (0.82 - 1.21)	1.01 (0.74 - 1.39)
75,000 or more	0.70*** (0.60 - 0.81)	0.66*** (0.55 - 0.80)	0.72* (0.54 - 0.95)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	0.99 (0.88 - 1.11)	1.08 (0.93 - 1.24)	0.76* (0.60 - 0.96)
Non-metropolitan	0.95 (0.82 - 1.09)	0.93 (0.78 - 1.12)	0.67** (0.51 - 0.89)
Health status			
Fair/poor= ref			
Good health	0.83* (0.72 - 0.96)	0.80* (0.66 - 0.96)	1.17 (0.89 - 1.53)
Major Depression Episode (MDE)			
No= ref			
Yes	2.14*** (1.89 - 2.42)	2.60*** (2.24 - 3.02)	1.51*** (1.18 - 1.92)
Post ACA			
	1.33* (1.07 - 1.66)	1.28 (0.97 - 1.68)	1.50 (0.95 - 2.38)
Post ACA* health insurance types			
Post ACA* Uninsured = ref			
Post ACA * Medicaid	1.06 (0.79 - 1.42)	0.86 (0.58 - 1.26)	1.56 (0.86 - 2.80)
Post ACA * Private	0.84 (0.64 - 1.10)	0.86 (0.62 - 1.21)	0.86 (0.49 - 1.51)
Post ACA * Medicare and other	0.87 (0.56 - 1.35)	0.98 (0.58 - 1.66)	1.03 (0.37 - 2.89)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

Table 1-A2. Adjusted associations of TOOS utilization (versus self-help) and different types of health insurance coverage, controlling for sociodemographic characteristics and interaction of post ACA and health insurance types

	Any SUD		Any AUD		Any OUD	
Sample size	1,696	3,406	1,069	2,125	494	1,191
Population size	6,732,414	14,029,360	4,353,406	9,058,392	1,795,907	4,728,784
	TOOS only	Any TOOS	TOOS only	Any TOOS	TOOS only	Any TOOS
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Health insurance						
No insurance = reference						
Medicaid	2.60** (1.44 - 4.68)	2.51*** (1.50 - 4.18)	2.06 (1.00 - 4.26)	1.86 (1.00 - 3.47)	5.18** (1.61 - 16.68)	5.94** (2.03 - 17.42)
Private	1.01 (0.61 - 1.66)	1.00 (0.66 - 1.51)	1.00 (0.55 - 1.79)	0.91 (0.56 - 1.48)	2.15 (0.84 - 5.51)	1.94 (0.88 - 4.28)
Medicare and others	0.44 (0.19 - 1.04)	0.65 (0.32 - 1.31)	0.55 (0.19 - 1.58)	0.63 (0.27 - 1.45)	0.26 (0.05 - 1.36)	0.60 (0.15 - 2.39)
Age in years						
18-25= reference						
26-34	0.88 (0.61 - 1.27)	1.02 (0.75 - 1.41)	0.79 (0.50 - 1.25)	0.97 (0.66 - 1.43)	1.47 (0.72 - 3.03)	1.62 (0.83 - 3.17)
35-49	0.70 (0.48 - 1.01)	0.85 (0.62 - 1.15)	0.60* (0.38 - 0.96)	0.80 (0.56 - 1.15)	1.46 (0.70 - 3.03)	1.16 (0.60 - 2.27)
50-64	0.85 (0.48 - 1.52)	1.15 (0.70 - 1.87)	0.88 (0.45 - 1.71)	1.27 (0.73 - 2.23)	3.62 (0.76 - 17.29)	4.69* (1.06 - 20.84)
Sex						
Female= reference						
Male	0.69* (0.50 - 0.96)	0.75 (0.56 - 1.01)	0.81 (0.54 - 1.20)	0.81 (0.56 - 1.16)	0.75 (0.42 - 1.33)	0.79 (0.45 - 1.39)
Race						
Non-Hispanic Whites= ref						
Non- Hispanic African Americans	0.95 (0.58 - 1.57)	1.26 (0.82 - 1.93)	1.38 (0.74 - 2.54)	1.62 (0.97 - 2.69)	1.09 (0.35 - 3.41)	2.49 (0.76 - 8.17)
Hispanic	0.73 (0.46 - 1.18)	0.80 (0.54 - 1.18)	0.98 (0.55 - 1.74)	0.90 (0.57 - 1.43)	0.65 (0.27 - 1.60)	0.98 (0.44 - 2.17)
Other race/ethnicity	0.77 (0.41 - 1.45)	0.83 (0.50 - 1.40)	1.40 (0.68 - 2.91)	1.33 (0.75 - 2.36)	1.12 (0.31 - 3.99)	1.03 (0.39 - 2.70)

Education						
High school or less=ref						
High school or more	1.10	0.93	1.22	0.87	0.96	0.78
	(0.75 - 1.61)	(0.67 - 1.27)	(0.74 - 2.00)	(0.59 - 1.30)	(0.47 - 1.97)	(0.41 - 1.48)
Total annual family income						
< \$50,000= ref						
\$ 50,000-74,999	1.10	1.11	1.35	1.14	1.21	1.21
	(0.68 - 1.78)	(0.72 - 1.70)	(0.78 - 2.35)	(0.69 - 1.87)	(0.55 - 2.66)	(0.57 - 2.58)
75,000 or more	1.52	1.22	1.66	1.21	1.32	1.51
	(0.99 - 2.33)	(0.86 - 1.75)	(0.99 - 2.78)	(0.80 - 1.84)	(0.54 - 3.22)	(0.73 - 3.12)
Urbanicity						
Large metropolitan= ref						
Small metropolitan	1.21	1.05	1.30	1.04	1.42	1.40
	(0.87 - 1.69)	(0.78 - 1.41)	(0.86 - 1.96)	(0.74 - 1.48)	(0.71 - 2.83)	(0.75 - 2.58)
Non-metropolitan	1.37	1.13	1.65	1.27	1.68	1.36
	(0.90 - 2.07)	(0.81 - 1.59)	(0.97 - 2.82)	(0.83 - 1.92)	(0.81 - 3.48)	(0.75 - 2.48)
Health status						
Fair/poor= ref						
Good health	0.57**	0.75	0.52*	0.75	0.93	1.03
	(0.38 - 0.86)	(0.53 - 1.07)	(0.31 - 0.87)	(0.49 - 1.13)	(0.44 - 1.94)	(0.53 - 2.00)
Major Depression Episode (MDE)						
No= ref						
Yes	0.92	1.31	0.72	1.17	1.13	1.51
	(0.65 - 1.28)	(0.97 - 1.77)	(0.48 - 1.07)	(0.82 - 1.66)	(0.58 - 2.19)	(0.84 - 2.72)
Post ACA						
	1.17	0.97	0.94	0.71	1.55	1.48
	(0.65 - 2.13)	(0.60 - 1.57)	(0.44 - 2.01)	(0.38 - 1.29)	(0.54 - 4.39)	(0.60 - 3.63)
Post ACA* health insurance types						
PostACA*						
Uninsured						
Post ACA*	0.66	0.78	0.96	1.20	0.30	0.25
Medicaid						
	(0.28 - 1.53)	(0.38 - 1.60)	(0.31 - 2.98)	(0.49 - 2.98)	(0.06 - 1.46)	(0.06 - 1.05)
Post ACA* Private	1.42	1.62	1.80	2.10	0.59	1.07
	(0.65 - 3.08)	(0.85 - 3.06)	(0.69 - 4.70)	(0.97 - 4.56)	(0.14 - 2.61)	(0.31 - 3.71)
Post ACA*	4.27*	3.28*	5.26*	3.89*	6.72	4.27
Medicare and other						

(1.23 - 14.82)	(1.13 - 9.55)	(1.20 - 23.10)	(1.12 - 13.48)	(0.25 - 178.36)	(0.30 - 60.52)
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***p<0.001, **p<0.01, *p<0.05

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Appendix 1-B

Table 1-B1. Adjusted associations of any treatment utilization past year, TOOS (vs. self-help) and different types of health insurance coverage, among people with substance abuse

	Any treatment	Only TOOS	Any TOOS
Sample size	17,997	467	813
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Health insurance			
No insurance = reference			
Medicaid	1.91*** (1.41 - 2.60)	2.22 (0.99 - 5.01)	1.95 (0.97 - 3.92)
Private	0.56*** (0.43 - 0.73)	1.31 (0.62 - 2.76)	1.08 (0.59 - 1.99)
Medicare and others	1.32 (0.88 - 2.00)	1.05 (0.33 - 3.34)	1.07 (0.43 - 2.68)
Age in years			
18-25= reference			
26-34	1.08 (0.86 - 1.36)	0.67 (0.35 - 1.30)	0.61 (0.35 - 1.08)
35-49	1.28* (1.02 - 1.61)	0.94 (0.46 - 1.92)	0.83 (0.46 - 1.51)
50-64	0.94 (0.62 - 1.42)	0.31 (0.09 - 1.07)	0.68 (0.24 - 1.90)
Sex			
Female= reference			
Male	1.48*** (1.20 - 1.82)	0.92 (0.50 - 1.68)	0.84 (0.48 - 1.46)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	1.19 (0.88 - 1.60)	0.80 (0.33 - 1.93)	0.79 (0.39 - 1.59)
Hispanic	0.78 (0.58 - 1.05)	1.15 (0.52 - 2.53)	0.96 (0.50 - 1.83)
Other race/ethnicity	1.08 (0.72 - 1.64)	0.72 (0.22 - 2.34)	0.69 (0.26 - 1.82)
Education			
High school or less=ref			

High school or more	0.55*** (0.43 - 0.71)	1.28 (0.65 - 2.55)	0.85 (0.48 - 1.50)
Total annual family income			
< \$50,000= ref			
\$ 50,000-74,999	0.88 (0.64 - 1.21)	2.37 (0.86 - 6.50)	1.63 (0.66 - 4.03)
75,000 or more	0.81 (0.61 - 1.08)	0.91 (0.45 - 1.82)	0.72 (0.39 - 1.32)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	1.34** (1.07 - 1.67)	1.12 (0.57 - 2.16)	0.86 (0.49 - 1.50)
Non-metropolitan	1.17 (0.88 - 1.55)	1.84 (0.86 - 3.93)	1.06 (0.57 - 1.98)
Health status			
Fair/poor= ref			
Good health	0.76 (0.56 - 1.04)	0.52 (0.23 - 1.18)	0.49 (0.22 - 1.12)
Major Depression Episode (MDE)			
No= ref			
Yes	1.33* (1.02 - 1.74)	0.89 (0.40 - 1.98)	1.44 (0.70 - 2.96)
Post ACA			
	0.92 (0.74 - 1.15)	1.10 (0.60 - 2.03)	0.87 (0.50 - 1.51)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-B2. Adjusted associations of any treatment utilization past year, TOOS (vs. self-help) and different types of health insurance coverage, among people with substance dependence.

	Any treatment 22,572	Only TOOS 1,323	Any TOOS 2,785
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Health insurance			
No insurance = reference			
Medicaid	2.10*** (1.77 - 2.48)	1.90** (1.18 - 3.04)	2.07*** (1.39 - 3.10)
Private	0.73*** (0.62 - 0.86)	1.05 (0.66 - 1.65)	1.11 (0.76 - 1.64)
Medicare and others	1.35* (1.04 - 1.75)	0.74 (0.37 - 1.49)	0.89 (0.46 - 1.72)
Age in years			
18-25= reference			
26-34	1.30*** (1.14 - 1.49)	0.99 (0.66 - 1.50)	1.19 (0.82 - 1.72)
35-49	1.53*** (1.34 - 1.75)	0.66 (0.43 - 1.00)	0.85 (0.60 - 1.20)
50-64	1.67*** (1.34 - 2.08)	0.96 (0.51 - 1.81)	1.30 (0.75 - 2.26)
Sex			
Female= reference			
Male	1.35*** (1.19 - 1.52)	0.65* (0.45 - 0.94)	0.77 (0.55 - 1.08)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.60*** (0.50 - 0.72)	1.08 (0.60 - 1.97)	1.59 (0.95 - 2.64)
Hispanic	0.61*** (0.50 - 0.74)	0.68 (0.39 - 1.18)	0.80 (0.51 - 1.24)
Other race/ethnicity	0.67*** (0.54 - 0.83)	0.92 (0.45 - 1.88)	1.00 (0.56 - 1.80)
Education			
High school or less=ref			
High school or more	0.88 (0.74 - 1.03)	1.11 (0.71 - 1.72)	1.02 (0.71 - 1.46)

Total annual family income

< \$50,000= ref			
\$ 50,000-74,999	0.99 (0.83 - 1.18)	1.16 (0.71 - 1.89)	1.14 (0.73 - 1.80)
75,000 or more	0.72***	1.96*	1.62*

Urbanicity

Large metropolitan= ref			
Small metropolitan	0.91 (0.80 - 1.03)	1.30 (0.90 - 1.89)	1.13 (0.82 - 1.56)
Non-metropolitan	0.92 (0.78 - 1.08)	1.37 (0.86 - 2.19)	1.20 (0.82 - 1.77)

Health status

Fair/poor= ref			
Good health	0.91 (0.77 - 1.06)	0.57* (0.37 - 0.88)	0.80 (0.54 - 1.17)

Major Depression Episode (MDE)

No= ref			
Yes	2.03*** (1.77 - 2.32)	0.88 (0.61 - 1.26)	1.17 (0.85 - 1.61)

Post ACA

1.17* (1.04 - 1.32)	1.46* (1.03 - 2.09)	1.28 (0.95 - 1.73)
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***p<0.001, **p<0.01, *p<0.05

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-B3. Adjusted associations of any treatment utilization past year, TOOS (vs. self-help) and different types of health insurance coverage, among people with alcohol abuse

	Any treatment	Only TOOS	Any TOOS
Sample size	15,896	382	692
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Health insurance			
No insurance = reference			
Medicaid	1.82*** (1.30 - 2.55)	2.32 (0.92 - 5.89)	1.73 (0.80 - 3.77)
Private	0.60*** (0.44 - 0.81)	2.09 (0.93 - 4.66)	1.73 (0.88 - 3.40)
Medicare and others	1.27 (0.81 - 1.99)	1.59 (0.47 - 5.37)	1.81 (0.67 - 4.89)
Age in years			
18-25= reference			
26-34	0.94 (0.73 - 1.20)	0.82 (0.37 - 1.80)	0.76 (0.40 - 1.46)
35-49	1.21 (0.94 - 1.54)	1.02 (0.47 - 2.21)	1.02 (0.55 - 1.92)
50-64	0.61 (0.37 - 1.00)	0.68 (0.16 - 2.86)	0.75 (0.23 - 2.48)
Sex			
Female= reference			
Male	1.58*** (1.25 - 1.99)	0.85 (0.41 - 1.78)	0.72 (0.40 - 1.31)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	1.16 (0.83 - 1.61)	0.71 (0.25 - 2.07)	0.67 (0.30 - 1.47)
Hispanic	0.82 (0.59 - 1.12)	1.45 (0.66 - 3.19)	1.09 (0.55 - 2.15)
Other race/ethnicity	1.03 (0.67 - 1.59)	1.27 (0.39 - 4.13)	1.02 (0.37 - 2.83)
Education			
High school or less=ref			
High school or more	0.53*** (0.40 - 0.71)	1.05 (0.47 - 2.35)	0.65 (0.34 - 1.26)
Total annual family income			
< \$50,000= ref			

\$ 50,000-74,999	1.41** (1.11 - 1.78)	1.04 (0.51 - 2.13)	0.82 (0.45 - 1.51)
75,000 or more	1.13 (0.83 - 1.55)	1.48 (0.64 - 3.40)	0.99 (0.48 - 2.04)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	1.41** (1.11 - 1.78)	1.04 (0.51 - 2.13)	0.82 (0.45 - 1.51)
Non-metropolitan	1.13 (0.83 - 1.55)	1.48 (0.64 - 3.40)	0.99 (0.48 - 2.04)
Health status			
Fair/poor= ref			
Good health	0.68* (0.49 - 0.95)	0.46 (0.18 - 1.17)	0.37* (0.15 - 0.94)
Major Depression Episode (MDE)			
No= ref			
Yes	1.39* (1.05 - 1.85)	1.25 (0.55 - 2.82)	2.37* (1.12 - 5.01)
Post ACA			
	1.27* (1.02 - 1.59)	0.92 (0.47 - 1.79)	0.87 (0.51 - 1.51)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-B4. Adjusted associations of any treatment utilization past year, TOOS (vs. self-help) and different types of health insurance coverage, among people with alcohol dependence

	Any treatment	Only TOOS	Any TOOS
Sample size	14,323	687	1,433
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Health insurance			
No insurance = reference			
Medicaid	1.90*** (1.50 - 2.41)	1.60 (0.81 - 3.15)	2.01* (1.12 - 3.59)
Private	0.83 (0.67 - 1.03)	0.92 (0.50 - 1.69)	0.93 (0.57 - 1.51)
Medicare and others	1.52* (1.09 - 2.12)	1.01 (0.42 - 2.44)	0.84 (0.38 - 1.83)
Age in years			
18-25= reference			
26-34	1.24* (1.03 - 1.49)	0.77 (0.44 - 1.36)	1.00 (0.62 - 1.61)
35-49	1.51*** (1.26 - 1.80)	0.51* (0.28 - 0.93)	0.73 (0.47 - 1.14)
50-64	1.92*** (1.48 - 2.49)	0.90 (0.43 - 1.89)	1.25 (0.66 - 2.38)
Sex			
Female= reference			
Male	1.55*** (1.31 - 1.83)	0.78 (0.47 - 1.27)	0.88 (0.57 - 1.36)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.74* (0.58 - 0.94)	2.45* (1.10 - 5.44)	3.50*** (1.74 - 7.02)
Hispanic	0.68** (0.52 - 0.89)	0.68 (0.31 - 1.48)	0.80 (0.45 - 1.44)
Other race/ethnicity	0.81 (0.61 - 1.06)	1.38 (0.55 - 3.44)	1.38 (0.69 - 2.77)
Education			
High school or less=ref			
High school or more	0.84	1.18	1.03

	(0.66 - 1.06)	(0.62 - 2.27)	(0.63 - 1.69)
Total annual family income			
< \$50,000= ref			
\$ 50,000-74,999	0.99	1.54	1.22
	(0.78 - 1.26)	(0.85 - 2.77)	(0.69 - 2.14)
75,000 or more	0.66***	2.45*	1.81*
	(0.52 - 0.84)	(1.22 - 4.90)	(1.03 - 3.17)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	0.98	1.43	1.15
	(0.82 - 1.17)	(0.88 - 2.33)	(0.76 - 1.76)
Non-metropolitan	0.90	1.82	1.45
	(0.72 - 1.13)	(0.96 - 3.45)	(0.87 - 2.43)
Health status			
Fair/poor= ref			
Good health	0.87	0.55	0.89
	(0.70 - 1.09)	(0.30 - 1.00)	(0.55 - 1.43)
Major Depression Episode (MDE)			
No= ref			
Yes	2.68***	0.67	0.98
	(2.25 - 3.19)	(0.42 - 1.06)	(0.65 - 1.46)
Post ACA			
	1.03	1.78*	1.28
	(0.87 - 1.21)	(1.09 - 2.92)	(0.86 - 1.91)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-B5. Adjusted associations of any treatment utilization past year, TOOS (vs. self-help) and different types of health insurance coverage, among people with opioid abuse

Sample size	Any treatment 719	Only TOOS 51	Any TOOS 102
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Health insurance			
No insurance = reference			
Medicaid	1.67 (0.71 - 3.89)	1.78 (0.16 - 19.69)	4.07 (0.76 - 21.70)
Private	0.51 (0.24 - 1.10)	0.14 (0.01 - 3.02)	1.80 (0.26 - 12.40)
Medicare and others	1.11 (0.39 - 3.18)	0.59 (0.04 - 9.47)	0.67 (0.08 - 5.97)
Age in years			
18-25= reference			
26-34	1.26 (0.64 - 2.46)	3.21 (0.17 - 62.00)	1.71 (0.28 - 10.26)
35-49	1.18 (0.61 - 2.28)	0.59 (0.03 - 13.19)	0.49 (0.08 - 2.93)
50-64	0.47 (0.14 - 1.62)		
Sex			
Female= reference			
Male	2.24** (1.26 - 3.98)	1.74 (0.22 - 13.78)	1.68 (0.51 - 5.47)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.78 (0.30 - 2.05)	4.41 (0.13 - 155.28)	2.67 (0.17 - 41.57)
Hispanic	0.32* (0.12 - 0.82)	0.65 (0.04 - 9.79)	1.51 (0.22 - 10.44)
Other race/ethnicity	0.40* (0.16 - 0.97)	0.50 (0.02 - 13.93)	0.89 (0.07 - 11.10)
Education			
High school or less=ref			
High school or more	1.09 (0.55 - 2.13)	0.38 (0.03 - 4.92)	0.55 (0.05 - 5.74)
Total annual family income			
< \$50,000= ref			

\$ 50,000-74,999	1.63 (0.61 - 4.35)	1.83 (0.06 - 57.83)	0.39 (0.04 - 3.56)
75,000 or more	1.19 (0.63 - 2.27)	1.94 (0.15 - 25.46)	4.72 (0.51 - 43.87)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	0.83 (0.43 - 1.62)	2.78 (0.26 - 30.15)	2.85 (0.53 - 15.44)
Non-metropolitan	0.97 (0.48 - 1.94)	2.04 (0.15 - 28.06)	1.13 (0.15 - 8.46)
Health status			
Fair/poor= ref			
Good health	0.49* (0.25 - 0.97)	1.60 (0.04 - 61.02)	1.20 (0.29 - 4.92)
Major Depression Episode (MDE)			
No= ref			
Yes	2.31** (1.24 - 4.29)	0.20 (0.02 - 2.37)	0.53 (0.13 - 2.20)
Post ACA			
	0.89 (0.49 - 1.61)	0.49 (0.06 - 3.88)	1.00 (0.27 - 3.74)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-B6. Adjusted associations of any treatment utilization past year, TOOS (vs. self-help) and different types of health insurance coverage, among people with opioid dependence

	Any treatment	Only TOOS	Any TOOS
Sample size	3,293	451	1,111
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Health insurance			
No insurance = reference			
Medicaid	2.40*** (1.78 - 3.25)	2.52* (1.18 - 5.42)	2.43** (1.26 - 4.70)
Private	1.25 (0.92 - 1.68)	1.90 (0.86 - 4.20)	2.04 (0.97 - 4.29)
Medicare and others	1.78* (1.01 - 3.14)	0.89 (0.20 - 3.85)	1.38 (0.34 - 5.59)
Age in years			
18-25= reference			
26-34	1.06 (0.83 - 1.35)	1.44 (0.70 - 2.95)	1.66 (0.82 - 3.35)
35-49	1.19 (0.90 - 1.58)	1.48 (0.67 - 3.24)	1.30 (0.63 - 2.72)
50-64	1.13 (0.72 - 1.77)	3.62 (0.76 - 17.18)	4.39* (1.01 - 19.06)
Sex			
Female= reference			
Male	1.17 (0.92 - 1.48)	0.73 (0.39 - 1.34)	0.86 (0.48 - 1.55)
Race			
Non-Hispanic Whites= ref			
Non- Hispanic African Americans	0.90 (0.59 - 1.39)	1.10 (0.33 - 3.65)	2.27 (0.65 - 7.88)
Hispanic	0.87 (0.60 - 1.25)	0.76 (0.28 - 2.07)	1.01 (0.43 - 2.37)
Other race/ethnicity	0.43*** (0.26 - 0.70)	1.22 (0.35 - 4.27)	1.13 (0.43 - 2.96)
Education			
High school or less=ref			
High school or more	1.02 (0.78 - 1.33)	1.15 (0.53 - 2.51)	0.83 (0.40 - 1.72)
Total annual family income			

< \$50,000= ref			
\$ 50,000-74,999	0.92 (0.66 - 1.28)	1.20 (0.54 - 2.65)	1.17 (0.55 - 2.49)
75,000 or more	0.66** (0.48 - 0.90)	1.35 (0.57 - 3.18)	1.34 (0.64 - 2.80)
Urbanicity			
Large metropolitan= ref			
Small metropolitan	0.76* (0.59 - 0.97)	1.39 (0.69 - 2.79)	1.25 (0.65 - 2.39)
Non-metropolitan	0.64** (0.47 - 0.86)	1.82 (0.85 - 3.86)	1.46 (0.75 - 2.84)
Health status			
Fair/poor= ref			
Good health	1.35* (1.01 - 1.79)	0.76 (0.35 - 1.64)	0.86 (0.42 - 1.77)
Major Depression Episode (MDE)			
No= ref			
Yes	1.43** (1.12 - 1.84)	1.22 (0.61 - 2.44)	1.75 (0.91 - 3.36)
Post ACA			
	1.82*** (1.44 - 2.29)	1.04 (0.57 - 1.92)	1.10 (0.66 - 1.86)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Appendix 1-C

Table 1-C1. Adjusted associations among those with any pain reliver, any heroin use disorders

	Any pain reliver use disorder	Any heroin use disorder
Sample size	3,293	1,071
Population size	12,977,145	3,959,977
	Any SUD treatment past year	Any SUD treatment past year
	AOR	AOR
	(95% CI)	(95% CI)
Health insurance		
No insurance = reference		
Medicaid	1.86*** (1.34 - 2.58)	3.21*** (1.95 - 5.27)
Private	0.98 (0.72 - 1.34)	2.53*** (1.56 - 4.10)
Medicare and others	1.20 (0.67 - 2.15)	4.13*** (1.88 - 9.08)
Age in years		
18-25= reference		
26-34	0.97 (0.75 - 1.25)	1.30 (0.88 - 1.93)
35-49	1.17 (0.88 - 1.54)	2.29** (1.33 - 3.94)
50-64	1.07 (0.66 - 1.74)	3.35* (1.08 - 10.39)
Sex		
Female= reference		
Male	1.21 (0.94 - 1.56)	0.90 (0.61 - 1.33)
Race		
Non-Hispanic Whites= ref		
Non- Hispanic African Americans	0.73 (0.46 - 1.13)	0.53 (0.23 - 1.24)
Hispanic	0.56** (0.37 - 0.86)	1.07 (0.60 - 1.89)
Other race/ethnicity	0.39*** (0.24 - 0.63)	0.47 (0.20 - 1.09)
Education		
High school or less=ref		
High school or more	1.16 (0.87 - 1.54)	1.11 (0.72 - 1.72)
Total annual family income		
< \$50,000= ref		
\$ 50,000-74,999	0.96 (0.68 - 1.37)	1.83* (1.04 - 3.20)
75,000 or more	0.70* (0.51 - 0.97)	0.91 (0.56 - 1.48)
Urbanicity		
Large metropolitan= ref		
Small metropolitan	0.82 (0.63 - 1.06)	0.61* (0.40 - 0.93)
Non-metropolitan	0.82 (0.61 - 1.12)	0.52* (0.30 - 0.92)

Health status		
Fair/poor= ref		
Good health	1.19 (0.88 - 1.62)	1.47 (0.95 - 2.28)
Major Depression Episode (MDE)		
No= ref		
Yes	1.47** (1.12 - 1.91)	2.60*** (1.69 - 4.01)
Post ACA		
	1.50** (1.17 - 1.92)	2.00*** (1.36 - 2.94)

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

AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

Table 1-C2. Adjusted associations of TOOS (vs self-help only) and insurance types among those with any pain reliever, heroin use disorders

	Any pain reliever use disorder		Any heroin use disorder	
Sample size	366	867	203	551
Population size	1,403,641	3,507,654	689,798.78	2,019,958
	TOOS only	Any TOOS	TOOS only	Any TOOS
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Health insurance				
No insurance = reference				
Medicaid	3.51** (1.43 - 8.60)	2.97** (1.46 - 6.05)	1.77 (0.57 - 5.53)	1.93 (0.78 - 4.81)
Private	2.15 (0.87 - 5.34)	2.38* (1.10 - 5.18)	0.73 (0.22 - 2.43)	1.45 (0.57 - 3.64)
Medicare and others	0.51 (0.12 - 2.29)	0.98 (0.25 - 3.77)	0.51 (0.10 - 2.59)	0.81 (0.18 - 3.63)
Age in years				
18-25= reference				
26-34	1.77 (0.69 - 4.54)	1.97 (0.84 - 4.64)	1.31 (0.53 - 3.23)	1.16 (0.50 - 2.70)
35-49	1.59 (0.70 - 3.62)	1.06 (0.50 - 2.21)	0.52 (0.18 - 1.51)	0.67 (0.27 - 1.71)
50-64	2.85 (0.59 - 13.77)	4.00 (0.93 - 17.23)	- -	- -
Sex				
Female= reference				
Male	0.94 (0.47 - 1.86)	0.98 (0.52 - 1.83)	0.46 (0.18 - 1.18)	0.48 (0.21 - 1.09)
Race				
Non-Hispanic Whites= ref				
Non- Hispanic African Americans	2.20 (0.45 - 10.91)	4.14* (1.10 - 15.60)	0.31 (0.05 - 1.95)	2.10 (0.21 - 20.67)
Hispanic	0.89 (0.25 - 3.10)	1.10 (0.40 - 3.06)	0.56 (0.15 - 2.11)	1.35 (0.41 - 4.43)
Other race/ethnicity	1.16 (0.26 - 5.21)	0.91 (0.29 - 2.85)	0.38 (0.05 - 2.60)	0.78 (0.18 - 3.40)
Education				
High school or less=ref				

High school or more	0.78 (0.34 - 1.78)	0.62 (0.31 - 1.24)	1.74 (0.54 - 5.58)	0.95 (0.34 - 2.65)
Total annual family income				
< \$50,000= ref				
\$ 50,000-74,999	1.51 (0.66 - 3.43)	1.09 (0.50 - 2.37)	1.30 (0.30 - 5.56)	1.95 (0.70 - 5.45)
75,000 or more	1.99 (0.70 - 5.63)	1.78 (0.78 - 4.05)	1.16 (0.37 - 3.65)	1.47 (0.57 - 3.80)
Urbanicity				
Large metropolitan= ref				
Small metropolitan	1.62 (0.66 - 3.97)	1.62 (0.75 - 3.46)	2.22 (0.83 - 5.90)	1.30 (0.61 - 2.77)
Non-metropolitan	2.25* (1.02 - 4.95)	1.93 (0.94 - 3.93)	3.10 (0.91 - 10.48)	1.87 (0.69 - 5.06)
Health status				
Fair/poor= ref				
Good health	0.87 (0.39 - 1.93)	1.02 (0.49 - 2.10)	1.10 (0.33 - 3.61)	1.48 (0.60 - 3.61)
Major Depression Episode (MDE)				
No= ref				
Yes	0.89 (0.44 - 1.83)	1.29 (0.70 - 2.36)	1.25 (0.39 - 3.96)	1.52 (0.64 - 3.64)
Post ACA				
	0.85 (0.43 - 1.68)	1.12 (0.64 - 1.95)	1.73 (0.64 - 4.66)	1.69 (0.83 - 3.46)

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

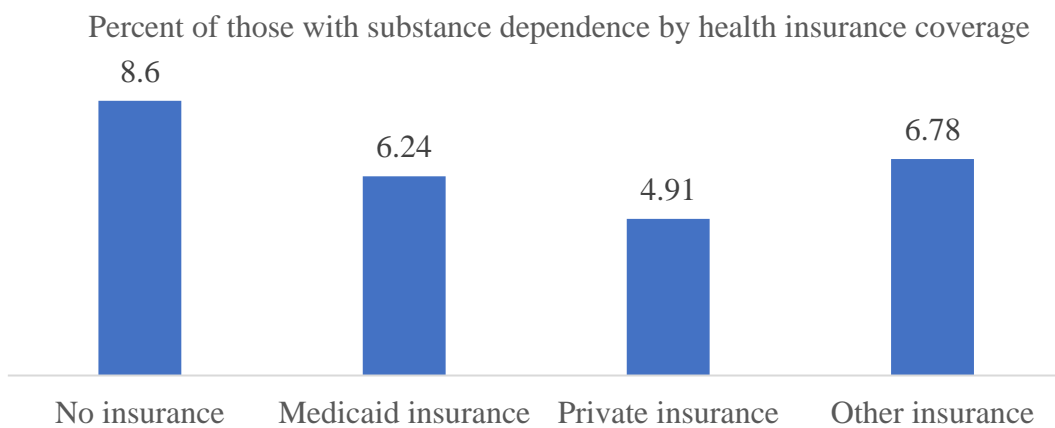
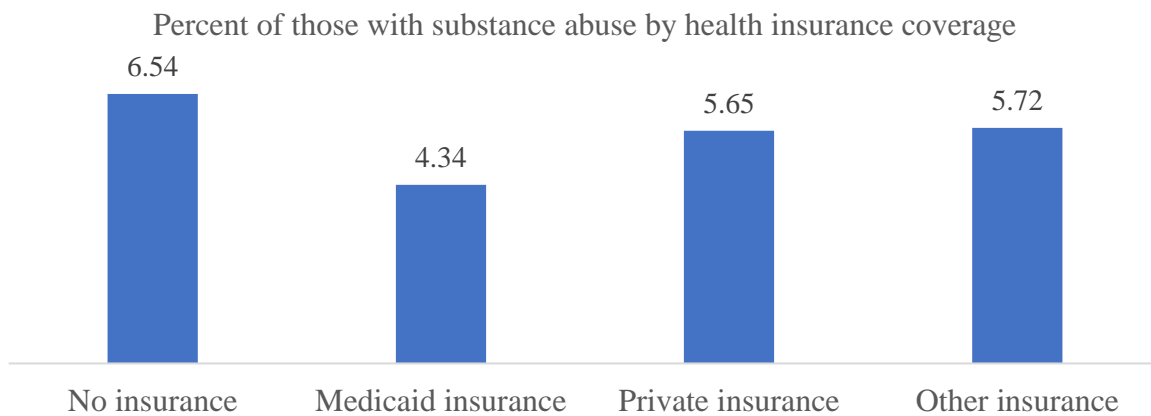
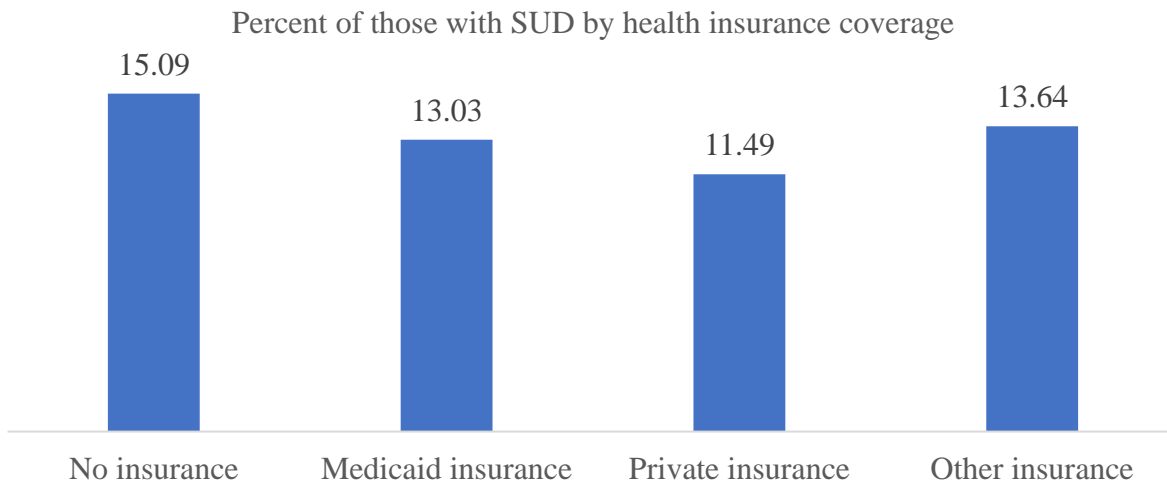
AOR= Adjusted Odd Ratios, CI= Confidence Interval

TOOS only= TOOS, no self-help versus self-help, no TOOS

Any TOOS = any TOOS versus self-help, no TOOS

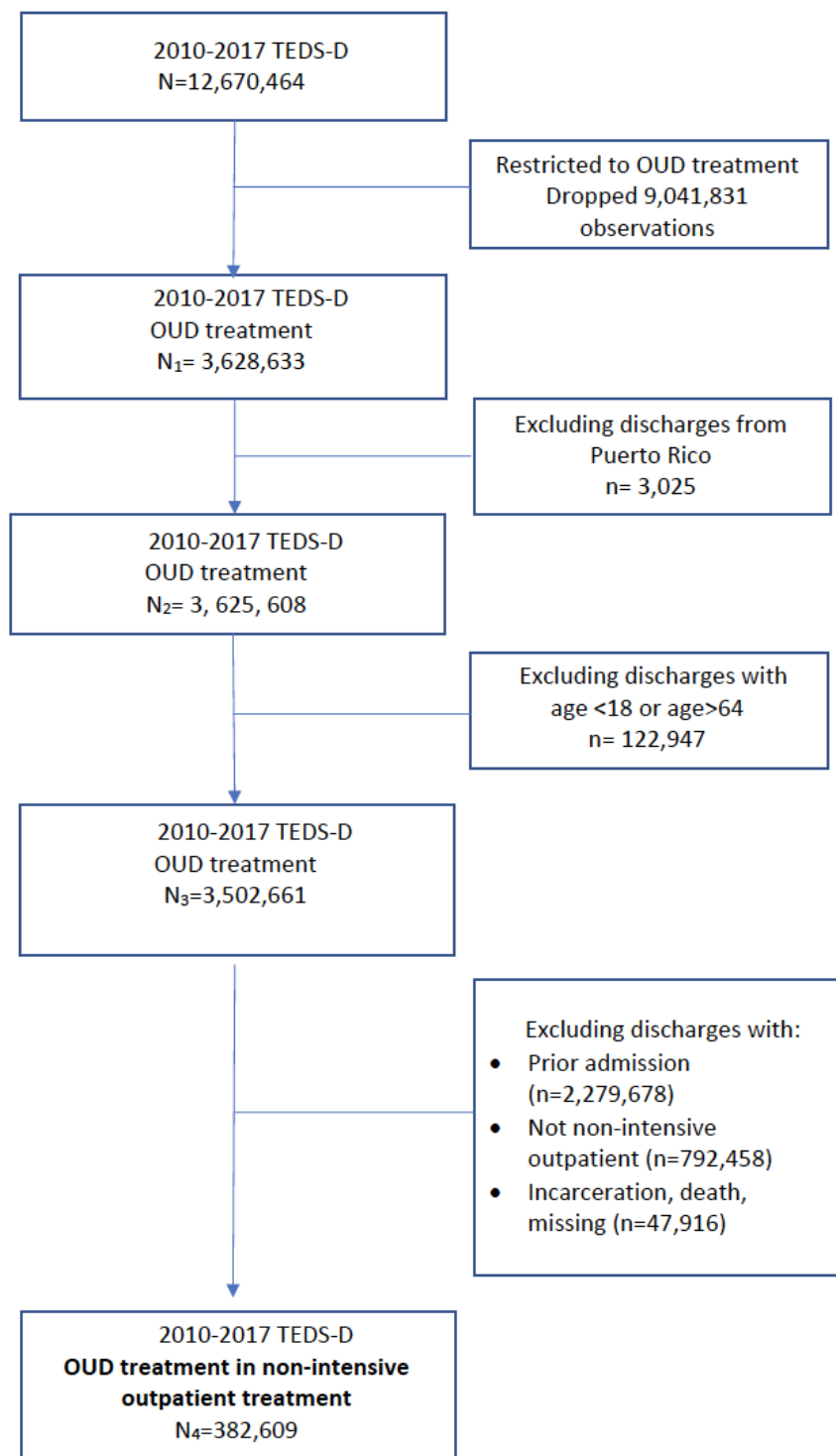
Appendix 1-D

Figure 1-D. Percent of those with substance use disorder by health insurance coverage



Appendix 2
Appendix 2-A

Figure 2-A Flowchart of the study sample



Appendix 2-B

Table 2-B. Summary of Medicaid Expansion and Section 1115 Demonstrations across states as of 2017

State	Expansion status	Section 1115 Demonstrations: Substance Use Disorders
Alabama	Not adopted	
Florida	Not adopted	
Kansas	Not adopted	
Mississippi	Not adopted	
Missouri	Not adopted	
North Carolina	Not adopted	(11/1/2019)
Oklahoma	Not adopted	
South Carolina	Not adopted	
South Dakota	Not adopted	
Tennessee	Not adopted	
Texas	Not adopted	
Wisconsin	Not adopted	1/1/2014
Wyoming	Not adopted	
Georgia	<i>Not adopted</i> (later adopted on 12/1/20)	
Nebraska	Not adopted (later adopted on 10/1/20)	(7/1/2019)
Idaho	Not adopted (later adopted on 1/1/20)	(4/17/2020)
Utah	Not adopted (later adopted on 1/1/20)	7/1/2002
Maine	Not adopted (later adopted on 1/10/19)	
Virginia	Not adopted (later adopted on 1/1/19)	4/1/2017
Louisiana	7/1/16	(2/1/2018)
Montana	1/1/16	
Alaska	9/1/15	(1/1/2019)
Indiana	2/1/15	2/1/2015
Pennsylvania	1/1/15	10/1/2017
New Hampshire	8/15/14	(7/10/2018)
Michigan	4/1/14	
Arizona	1/1/14	
Arkansas	1/1/14	1/1/2013
California	1/1/14	9/1/2005

Colorado	1/1/14	
Connecticut	1/1/14	
Delaware	1/1/14	1/1/1996
District of Columbia	1/1/14	(1/1/2020)
Hawaii	1/1/14	
Illinois	1/1/14	
Iowa	1/1/14	
Kentucky	1/1/14	(4/1/2019)
Maryland	1/1/14	7/1/1997
Massachusetts	1/1/14	7/1/1997
Minnesota	1/1/14	(10/1/2019)
Nevada	1/1/14	
New Jersey	1/1/14	10/2/2012
New Mexico	1/1/14	(1/1/2019)
New York	1/1/14	(10/1/2019)
North Dakota	1/1/14	
Ohio	1/1/14	(10/1/2019)
Oregon	1/1/14	
Rhode Island	1/1/14	7/1/2009
Vermont	1/1/14	10/1/2005
Washington	1/1/14	1/9/2017
West Virginia	1/1/14	(1/1/2018)

Appendix 2-C

Sensitivity analyses with additional covariates

Table 2-C1. Sensitivity analysis with added covariates: 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	231,025	231,025	231,025
	RRR (95%CI)	RRR (95%CI)	RRR (95%CI)
Medicaid expansion			
Yes	1.10** (1.04 - 1.16)	2.11*** (1.97 - 2.27)	1.28*** (1.22 - 1.35)
MAT (No= ref)			
Yes	0.64*** (0.62 - 0.66)	0.34*** (0.33 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use (No past month use= ref)			
Some use	0.64*** (0.62 - 0.67)	0.65*** (0.63 - 0.68)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.38)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.00 (0.96 - 1.03)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.85*** (0.82 - 0.88)
Gender (Female=ref)			
Male	0.88*** (0.85 - 0.90)	0.62*** (0.60 - 0.64)	1.31*** (1.28 - 1.35)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.01 (0.96 - 1.07)	1.36*** (1.28 - 1.44)	1.19*** (1.14 - 1.26)
Hispanic	0.90*** (0.85 - 0.95)	1.30*** (1.23 - 1.38)	1.21*** (1.15 - 1.27)
Other	0.88*** (0.82 - 0.95)	1.04 (0.96 - 1.12)	0.96 (0.90 - 1.03)
Education (Less than high school= ref)			

	0.96**	0.80***	0.78***
Highschool or higher			
	(0.93 - 0.99)	(0.78 - 0.83)	(0.76 - 0.80)
Number of arrests (0= ref)			
1	0.85*** (0.79 - 0.91)	1.19*** (1.12 - 1.28)	2.73*** (2.60 - 2.86)
2 or more	0.83** (0.74 - 0.93)	0.96 (0.83 - 1.11)	1.10 (1.00 - 1.21)
Employment status (Not employed= ref)			
Employed	1.32*** (1.28 - 1.36)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity (No= ref)			
Yes	1.49*** (1.45 - 1.53)	0.93*** (0.90 - 0.96)	0.65*** (0.63 - 0.67)
Homeless (No= ref)			
Yes	1.31*** (1.25 - 1.38)	1.35*** (1.28 - 1.44)	0.61*** (0.58 - 0.65)
Polysubstance use (no= ref)			
One more	0.99 (0.96 - 1.01)	1.02 (0.99 - 1.05)	0.85*** (0.83 - 0.88)
Two or more	0.97 (0.94 - 1.01)	1.06** (1.02 - 1.10)	0.95** (0.92 - 0.98)
Unemployment rate			
Unemployed rate	1.08*** (1.05 - 1.11)	1.11*** (1.08 - 1.15)	1.03* (1.01 - 1.06)
PMDP (No=ref)			
Yes	1.24*** (1.13 - 1.36)	1.44*** (1.31 - 1.59)	0.84*** (0.78 - 0.91)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Table 2-C2. Sensitivity analysis with added covariates: DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272 AOR (95%CI)	225,272 AOR (95%CI)	225,272 AOR (95%CI)
Expansion	0.92 (0.57 - 1.48)	1.04 (0.64 - 1.68)	1.07 (0.64 - 1.76)
Post expansion	1.09 (0.91 - 1.31)	0.64*** (0.53 - 0.78)	1.00 (0.84 - 1.18)
Expansion * Post expansion	1.11*** (1.04 - 1.17)	2.25*** (2.09 - 2.41)	1.29*** (1.23 - 1.37)
MAT (No= ref)			
Yes	0.65*** (0.63 - 0.67)	0.33*** (0.32 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.63 - 0.69)	0.38*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.39)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	0.99 (0.96 - 1.02)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.84*** (0.81 - 0.88)
Gender			
Male	0.88*** (0.86 - 0.90)	0.62*** (0.60 - 0.63)	1.31*** (1.28 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02 (0.97 - 1.07)	1.36*** (1.28 - 1.45)	1.19*** (1.13 - 1.26)
Hispanic	0.90*** (0.85 - 0.95)	1.32*** (1.24 - 1.40)	1.21*** (1.15 - 1.27)
Other	0.89** (0.82 - 0.96)	1.04 (0.96 - 1.13)	0.98 (0.92 - 1.06)
Education			
Highschool or higher	0.96* (0.94 - 0.99)	0.81*** (0.78 - 0.84)	0.78*** (0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83*** (0.78 - 0.89)	1.20*** (1.12 - 1.28)	2.73*** (2.60 - 2.87)
2 or more	0.85** (0.76 - 0.95)	0.96 (0.83 - 1.11)	1.09 (0.99 - 1.21)

Employment status			
Employed	1.33*** (1.29 - 1.37)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity			
Yes	1.51*** (1.47 - 1.55)	0.92*** (0.89 - 0.95)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.27 - 1.40)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	0.99 (0.97 - 1.02)	1.01 (0.98 - 1.05)	0.85*** (0.82 - 0.87)
Two or more	0.98 (0.95 - 1.02)	1.05** (1.02 - 1.09)	0.94*** (0.91 - 0.97)
Unemployment rate			
Unemployed rate	1.08*** (1.05 - 1.11)	1.09*** (1.06 - 1.12)	1.03* (1.00 - 1.06)
PMDP (No= ref)			
Yes	1.24*** (1.13 - 1.36)	1.50*** (1.36 - 1.65)	0.85*** (0.78 - 0.92)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Sensitivity analysis with lagged model

Table 2-D. Sensitivity analysis with lagged DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	AOR	AOR	AOR
	(95% CI)	(95% CI)	(95% CI)
Expansion	0.84	0.91	1.03
	(0.52 - 1.35)	(0.57 - 1.48)	(0.62 - 1.71)
Post expansion year 2014	0.91*	0.44***	1.16***
	(0.84 - 0.98)	(0.39 - 0.49)	(1.07 - 1.26)
Expansion * Post expansion Year 0 (or year 2014)	1.03	1.78***	1.04
	(0.94 - 1.13)	(1.57 - 2.01)	(0.96 - 1.13)
Post expansion year 1	1.08	1.09	0.88*
	(0.98 - 1.20)	(0.94 - 1.27)	(0.80 - 0.97)
Expansion* Post expansion year 1	0.98	1.04	1.12
	(0.87 - 1.10)	(0.88 - 1.23)	(1.00 - 1.25)
Post expansion year 2	0.74***	0.87*	1.00
	(0.67 - 0.82)	(0.76 - 1.00)	(0.91 - 1.10)
Expansion* Post expansion year 2	1.19**	1.26**	1.02
	(1.06 - 1.33)	(1.08 - 1.48)	(0.91 - 1.14)
Post expansion year 3	0.90**	0.83**	0.67***
	(0.83 - 0.97)	(0.74 - 0.93)	(0.62 - 0.72)
Expansion* Post expansion year 3	1.15**	1.35***	1.50***
	(1.04 - 1.27)	(1.19 - 1.54)	(1.37 - 1.65)
MAT (No= ref)			
Yes	0.65***	0.33***	0.14***
	(0.63 - 0.67)	(0.32 - 0.34)	(0.13 - 0.14)
Frequency of use			
Some use	0.64***	0.66***	0.38***
	(0.62 - 0.67)	(0.63 - 0.69)	(0.37 - 0.40)
Daily use	0.51***	0.38***	0.16***
	(0.50 - 0.53)	(0.36 - 0.39)	(0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00	0.99	0.99
	(0.97 - 1.03)	(0.96 - 1.03)	(0.96 - 1.01)
45-64	1.11***	0.77***	0.84***
	(1.07 - 1.15)	(0.74 - 0.81)	(0.81 - 0.88)
Gender			
Male	0.88***	0.62***	1.31***
	(0.85 - 0.90)	(0.60 - 0.63)	(1.28 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02	1.37***	1.20***

	(0.97 - 1.07)	(1.29 - 1.46)	(1.14 - 1.26)
Hispanic	0.89***	1.31***	1.21***
	(0.84 - 0.94)	(1.24 - 1.39)	(1.14 - 1.27)
Other	0.87***	1.02	0.97
	(0.81 - 0.94)	(0.95 - 1.11)	(0.91 - 1.04)
Education			
Highschool or higher	0.96*	0.81***	0.78***
	(0.94 - 0.99)	(0.79 - 0.84)	(0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83***	1.20***	2.74***
	(0.78 - 0.89)	(1.12 - 1.28)	(2.61 - 2.87)
2 or more	0.86*	0.97	1.09
	(0.77 - 0.97)	(0.83 - 1.12)	(0.99 - 1.20)
Employment status			
Employed	1.33***	1.14***	0.93***
	(1.29 - 1.37)	(1.10 - 1.18)	(0.91 - 0.96)
Comorbidity			
Yes	1.50***	0.91***	0.65***
	(1.46 - 1.54)	(0.89 - 0.94)	(0.63 - 0.67)
Homeless			
Yes	1.33***	1.35***	0.61***
	(1.27 - 1.41)	(1.27 - 1.43)	(0.57 - 0.65)
Polysubstance use			
One more	1.00	1.02	0.85***
	(0.97 - 1.03)	(0.99 - 1.06)	(0.83 - 0.88)
Two or more	0.99	1.07***	0.95**
	(0.96 - 1.03)	(1.03 - 1.11)	(0.92 - 0.98)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Appendix 2-E

Sensitivity analysis for discharges with many episodes

Table 2-E1. 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	518,154	518,154	518,154
	RRR	RRR	RRR
	(95%CI)	(95%CI)	(95%CI)
Medicaid expansion			
Yes	0.91*** (0.88 - 0.95)	1.34*** (1.26 - 1.42)	0.96 (0.92 - 1.01)
MAT (No= ref)			
Yes	0.53*** (0.52 - 0.54)	0.29*** (0.28 - 0.30)	0.13*** (0.13 - 0.13)
Frequency of use (No past month use= ref)			
Some use	0.52*** (0.51 - 0.53)	0.57*** (0.55 - 0.58)	0.36*** (0.35 - 0.37)
Daily use	0.49*** (0.49 - 0.50)	0.38*** (0.37 - 0.39)	0.19*** (0.19 - 0.20)
Age (18-29= ref)			
30-44	0.94*** (0.92 - 0.95)	1.04** (1.02 - 1.07)	0.90*** (0.88 - 0.92)
45-64	0.92*** (0.89 - 0.94)	0.86*** (0.84 - 0.89)	0.67*** (0.65 - 0.69)
Gender (Female=ref)			
Male	0.96*** (0.94 - 0.97)	0.74*** (0.72 - 0.75)	1.40*** (1.37 - 1.42)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.22*** (1.18 - 1.25)	1.36*** (1.31 - 1.42)	1.01 (0.97 - 1.04)
Hispanic	0.90*** (0.87 - 0.92)	1.24*** (1.20 - 1.28)	1.11*** (1.08 - 1.14)
Other	0.80*** (0.77 - 0.84)	0.84*** (0.80 - 0.89)	0.87*** (0.83 - 0.91)
Education (Less than high school= ref)			
Highschool or higher	1.00 (0.98 - 1.01)	0.83*** (0.81 - 0.85)	0.86*** (0.85 - 0.88)

Number of arrests (0= ref)			
1	0.79*** (0.76 - 0.82)	1.11*** (1.06 - 1.17)	2.35*** (2.27 - 2.43)
2 or more	0.67*** (0.62 - 0.73)	0.77*** (0.69 - 0.87)	1.33*** (1.24 - 1.44)
Employment status (Not employed= ref)			
Employed	1.32*** (1.29 - 1.35)	1.24*** (1.21 - 1.27)	0.95*** (0.93 - 0.97)
Comorbidity (No= ref)			
Yes	1.22*** (1.20 - 1.24)	0.97** (0.95 - 0.99)	0.76*** (0.75 - 0.77)
Homeless (No= ref)			
Yes	1.07*** (1.04 - 1.11)	1.39*** (1.34 - 1.44)	0.65*** (0.63 - 0.68)
Polysubstance use (no= ref)			
One more	1.00 (0.98 - 1.01)	1.11*** (1.09 - 1.14)	1.06*** (1.04 - 1.08)
Two or more	1.06*** (1.04 - 1.08)	1.24*** (1.21 - 1.27)	1.18*** (1.15 - 1.20)

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

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR.

Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results).

Table 2-E2. DID model for non-intensive outpatient treatment for OUD, many episodes

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Expansion	0.86 (0.55 - 1.33)	2.32** (1.30 - 4.16)	0.82 (0.54 - 1.24)
Post expansion	0.78*** (0.74 - 0.83)	0.79*** (0.73 - 0.85)	1.42*** (1.33 - 1.51)
Expansion * Post expansion	0.90*** (0.86 - 0.94)	1.36*** (1.28 - 1.44)	0.93** (0.88 - 0.97)
MAT (No= ref)			
Yes	0.54*** (0.53 - 0.55)	0.29*** (0.29 - 0.30)	0.13*** (0.13 - 0.14)
Frequency of use			
Some use	0.52*** (0.50 - 0.53)	0.57*** (0.56 - 0.59)	0.36*** (0.35 - 0.37)
Daily use	0.49*** (0.49 - 0.50)	0.39*** (0.38 - 0.39)	0.19*** (0.19 - 0.20)
Age (18-29= ref)			
30-44	0.94*** (0.92 - 0.96)	1.07*** (1.04 - 1.09)	0.91*** (0.89 - 0.93)
45-64	0.94*** (0.92 - 0.96)	0.96** (0.93 - 0.99)	0.68*** (0.67 - 0.70)
Gender			
Male	0.95*** (0.94 - 0.97)	0.75*** (0.73 - 0.76)	1.40*** (1.37 - 1.42)
Race/ethnicity			
Non-Hispanic Black	1.10*** (1.05 - 1.14)	1.04 (0.98 - 1.10)	0.86*** (0.81 - 0.90)
Hispanic	0.99 (0.95 - 1.03)	1.00 (0.95 - 1.05)	1.13*** (1.08 - 1.18)
Other	0.73*** (0.69 - 0.78)	0.75*** (0.70 - 0.81)	0.82*** (0.77 - 0.87)
Education			
Highschool or higher	1.00 (0.98 - 1.02)	0.81*** (0.79 - 0.83)	0.86*** (0.84 - 0.88)
Number of arrests (0=ref)			
1	0.79*** (0.76 - 0.82)	1.12*** (1.06 - 1.17)	2.35*** (2.27 - 2.43)
2 or more	0.68*** (0.62 - 0.74)	0.77*** (0.68 - 0.87)	1.34*** (1.24 - 1.44)
Employment status			
Employed	1.33*** (1.31 - 1.36)	1.27*** (1.24 - 1.31)	0.96*** (0.94 - 0.98)

Comorbidity			
Yes	1.21*** (1.19 - 1.23)	0.96*** (0.94 - 0.98)	0.76*** (0.75 - 0.78)
Homeless			
Yes	1.08*** (1.05 - 1.12)	1.42*** (1.37 - 1.47)	0.65*** (0.63 - 0.68)
Polysubstance use			
One more	1.00 (0.98 - 1.02)	1.11*** (1.08 - 1.14)	1.04*** (1.02 - 1.07)
Two or more	1.07*** (1.05 - 1.09)	1.24*** (1.21 - 1.27)	1.17*** (1.14 - 1.19)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Table 2E-3. 2WFE model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	169,449	169,449	169,449
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expanded	0.89*** (0.85 - 0.94)	1.26*** (1.17 - 1.35)	0.86*** (0.82 - 0.91)
Frequency of use (No past month use= ref)			
Some use	0.58*** (0.57 - 0.60)	0.59*** (0.57 - 0.61)	0.38*** (0.37 - 0.39)
Daily use	0.70*** (0.68 - 0.71)	0.42*** (0.41 - 0.44)	0.23*** (0.22 - 0.23)
Age (18-29= ref)			
30-44	0.96*** (0.93 - 0.98)	1.11*** (1.08 - 1.14)	0.94*** (0.92 - 0.96)
45-64	1.00 (0.97 - 1.03)	0.94** (0.91 - 0.98)	0.76*** (0.74 - 0.78)
Gender (Female=ref)			
Male	0.98* (0.96 - 1.00)	0.71*** (0.70 - 0.73)	1.39*** (1.36 - 1.41)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.40*** (1.35 - 1.46)	1.48*** (1.41 - 1.56)	1.06** (1.02 - 1.10)
Hispanic	1.02 (0.99 - 1.06)	1.45*** (1.39 - 1.51)	1.25*** (1.20 - 1.29)
Other	0.83*** (0.79 - 0.88)	0.86*** (0.80 - 0.92)	0.87*** (0.83 - 0.92)
Education (Less than high school= ref)			
Highschool or higher	0.96*** (0.94 - 0.98)	0.78*** (0.76 - 0.80)	0.82*** (0.80 - 0.83)
Number of arrests (0= ref)			
1	0.72*** (0.69 - 0.76)	1.07* (1.02 - 1.13)	1.96*** (1.89 - 2.04)
2 or more	0.59***	0.69***	1.12**

	(0.53 - 0.65)	(0.61 - 0.79)	(1.03 - 1.22)
Employment status (Not employed= ref)			
Employed	1.38*** (1.35 - 1.42)	1.24*** (1.21 - 1.28)	0.95*** (0.93 - 0.97)
Comorbidity (No= ref)			
Yes	1.20*** (1.18 - 1.23)	0.85*** (0.83 - 0.88)	0.70*** (0.68 - 0.71)
Homeless (No= ref)			
Yes	1.10*** (1.05 - 1.14)	1.43*** (1.37 - 1.50)	0.61*** (0.58 - 0.64)
Polysubstance use (no= ref)			
One more	0.92*** (0.89 - 0.94)	1.02 (0.99 - 1.05)	0.96*** (0.94 - 0.98)
Two or more	0.94*** (0.91 - 0.96)	1.09*** (1.06 - 1.12)	1.03** (1.01 - 1.06)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR.

Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Table 2E-4. 2WFE model for the associations among MAT, non-intensive outpatient treatment for OUD: logit models

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	166,400	141,859	141,885
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expanded	0.88** (0.81 - 0.95)	1.59*** (1.38 - 1.82)	1.15* (1.01 - 1.32)
Frequency of use (No past month use= ref)			
Some use	0.42*** (0.41 - 0.44)	0.61*** (0.58 - 0.65)	0.39*** (0.37 - 0.41)
Daily use	0.32*** (0.31 - 0.33)	0.41*** (0.39 - 0.43)	0.19*** (0.18 - 0.20)
Age (18-29= ref)			
30-44	0.91*** (0.88 - 0.94)	0.91*** (0.87 - 0.96)	0.74*** (0.70 - 0.77)
45-64	0.81*** (0.78 - 0.84)	0.75*** (0.71 - 0.80)	0.44*** (0.42 - 0.47)
Gender (Female=ref)			
Male	0.93*** (0.90 - 0.95)	0.81*** (0.78 - 0.85)	1.45*** (1.39 - 1.51)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.95* (0.91 - 1.00)	1.18*** (1.11 - 1.26)	0.99 (0.92 - 1.07)
Hispanic	0.83*** (0.79 - 0.86)	1.05 (0.99 - 1.12)	0.83*** (0.77 - 0.88)
Other	0.74*** (0.68 - 0.79)	0.83*** (0.75 - 0.92)	0.95 (0.84 - 1.07)
Education (Less than high school= ref)			
Highschool or higher	1.03* (1.00 - 1.06)	0.91*** (0.87 - 0.95)	1.01 (0.97 - 1.06)
Number of arrests (0= ref)			
1	0.88*** (0.82 - 0.94)	1.05 (0.95 - 1.15)	4.31*** (4.04 - 4.59)

2 or more	0.85 (0.71 - 1.00)	0.91 (0.72 - 1.16)	2.64*** (2.20 - 3.17)
Employment status (Not employed= ref)			
Employed	1.25*** (1.21 - 1.29)	1.29*** (1.23 - 1.36)	0.99 (0.94 - 1.04)
Comorbidity (No= ref)			
Yes	1.15*** (1.12 - 1.18)	1.23*** (1.18 - 1.28)	1.01 (0.97 - 1.05)
Homeless (No= ref)			
Yes	1.05* (1.00 - 1.10)	1.32*** (1.24 - 1.41)	0.82*** (0.76 - 0.90)
Polysubstance use (no= ref)			
One more	1.10*** (1.06 - 1.13)	1.25*** (1.19 - 1.31)	1.29*** (1.23 - 1.35)
Two or more	1.27*** (1.23 - 1.31)	1.45*** (1.37 - 1.52)	1.61*** (1.52 - 1.69)

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

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Table 2E-5. DID model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	313,253	313,253	313,253
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion	0.45* (0.20 - 0.99)	1.39 (0.54 - 3.56)	0.61 (0.31 - 1.21)
Post expansion	0.77*** (0.72 - 0.81)	0.70*** (0.65 - 0.76)	1.15*** (1.09 - 1.22)
Expansion * Post expansion	0.87*** (0.83 - 0.92)	1.29*** (1.20 - 1.38)	0.82*** (0.78 - 0.86)
Frequency of use (No past month use= ref)			
Some use	0.58*** (0.56 - 0.60)	0.59*** (0.57 - 0.61)	0.37*** (0.36 - 0.38)
Daily use	0.70*** (0.69 - 0.72)	0.43*** (0.42 - 0.44)	0.22*** (0.22 - 0.23)
Age (18-29= ref)			
30-44	0.96*** (0.94 - 0.98)	1.12*** (1.09 - 1.15)	0.95*** (0.93 - 0.97)
45-64	0.99 (0.96 - 1.02)	0.97 (0.93 - 1.00)	0.76*** (0.74 - 0.78)
Gender (Female=ref)			
Male	0.98 (0.96 - 1.00)	0.72*** (0.70 - 0.74)	1.38*** (1.35 - 1.41)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.43*** (1.37 - 1.48)	1.47*** (1.40 - 1.55)	1.06** (1.02 - 1.10)
Hispanic	1.03 (0.99 - 1.07)	1.45*** (1.39 - 1.51)	1.25*** (1.21 - 1.29)
Other	0.86*** (0.81 - 0.91)	0.86*** (0.80 - 0.92)	0.89*** (0.84 - 0.94)
Education (Less than high school= ref)			
Highschool or higher	0.96*** (0.93 - 0.98)	0.78*** (0.76 - 0.81)	0.82*** (0.80 - 0.84)
Number of arrests (0= ref)			

1	0.72*** (0.68 - 0.76)	1.08** (1.02 - 1.14)	1.95*** (1.87 - 2.02)
2 or more	0.60*** (0.54 - 0.67)	0.68*** (0.59 - 0.78)	1.11* (1.02 - 1.20)
Employment status (Not employed= ref)			
Employed	1.40*** (1.37 - 1.44)	1.26*** (1.22 - 1.30)	0.96*** (0.94 - 0.99)
Comorbidity (No= ref)			
Yes	1.21*** (1.18 - 1.24)	0.86*** (0.84 - 0.88)	0.70*** (0.68 - 0.71)
Homeless (No= ref)			
Yes	1.10*** (1.06 - 1.15)	1.43*** (1.36 - 1.50)	0.61*** (0.58 - 0.64)
Polysubstance use (no= ref)			
One more	0.91*** (0.89 - 0.94)	1.01 (0.98 - 1.04)	0.94*** (0.92 - 0.96)
Two or more	0.94*** (0.92 - 0.97)	1.08*** (1.05 - 1.12)	1.01 (0.99 - 1.04)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Table 2E-6. DID model for the associations among MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	60,852	60,852	60,852
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion	1.28 (0.68 - 2.41)	2.68* (1.15 - 6.28)	0.40** (0.21 - 0.78)
Post expansion	0.86*** (0.79 - 0.94)	0.77*** (0.66 - 0.89)	1.37*** (1.18 - 1.59)
Expansion * Post expansion	0.89** (0.82 - 0.96)	1.61*** (1.40 - 1.85)	1.17* (1.02 - 1.35)
Frequency of use (No past month use= ref)			
Some use	0.42*** (0.40 - 0.44)	0.62*** (0.58 - 0.65)	0.39*** (0.37 - 0.41)
Daily use	0.31*** (0.30 - 0.32)	0.41*** (0.39 - 0.43)	0.19*** (0.18 - 0.20)
Age (18-29= ref)			
30-44	0.91*** (0.88 - 0.94)	0.91*** (0.87 - 0.95)	0.74*** (0.71 - 0.78)
45-64	0.81*** (0.78 - 0.84)	0.75*** (0.71 - 0.80)	0.44*** (0.42 - 0.47)
Gender (Female=ref)			
Male	0.92*** (0.90 - 0.95)	0.81*** (0.78 - 0.84)	1.45*** (1.39 - 1.51)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96 (0.91 - 1.00)	1.18*** (1.11 - 1.26)	0.99 (0.92 - 1.07)
Hispanic	0.83*** (0.79 - 0.86)	1.06 (0.99 - 1.12)	0.82*** (0.77 - 0.88)
Other	0.74*** (0.68 - 0.79)	0.82*** (0.74 - 0.91)	0.96 (0.85 - 1.07)
Education (Less than high school= ref)			
Highschool or higher	1.03* (1.00 - 1.06)	0.91*** (0.87 - 0.95)	1.02 (0.97 - 1.06)
Number of arrests (0= ref)			

1	0.88*** (0.82 - 0.94)	1.05 (0.95 - 1.16)	4.29*** (4.02 - 4.58)
2 or more	0.84 (0.71 - 1.00)	0.94 (0.74 - 1.19)	2.67*** (2.22 - 3.21)
Employment status (Not employed= ref)			
Employed	1.25*** (1.21 - 1.30)	1.30*** (1.23 - 1.37)	0.99 (0.95 - 1.04)
Comorbidity (No= ref)			
Yes	1.14*** (1.11 - 1.18)	1.22*** (1.17 - 1.27)	1.00 (0.96 - 1.04)
Homeless (No= ref)			
Yes	1.05* (1.00 - 1.10)	1.33*** (1.24 - 1.42)	0.82*** (0.76 - 0.90)
Polysubstance use (no= ref)			
One more	1.09*** (1.06 - 1.12)	1.25*** (1.19 - 1.31)	1.28*** (1.22 - 1.35)
Two or more	1.27*** (1.23 - 1.31)	1.45*** (1.38 - 1.53)	1.61*** (1.52 - 1.69)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Appendix 2-F

Sensitivity analysis that added Section 1115 Demonstration Waiver

Table 2-F1. Sensitivity analysis that added Waiver 1115 Demonstrations: 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	231,025	231,025	231,025
	RRR (95%CI)	RRR (95%CI)	RRR (95%CI)
Medicaid expansion			
Yes	1.17*** (1.11 - 1.24)	2.26*** (2.11 - 2.42)	1.31*** (1.24 - 1.38)
Waiver 1115 Demonstrations			
Yes	1.04 (0.88 - 1.23)	1.21* (1.04 - 1.41)	1.03 (0.89 - 1.18)
MAT (No= ref)			
Yes	0.64*** (0.62 - 0.66)	0.34*** (0.33 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use (No past month use= ref)			
Some use	0.64*** (0.62 - 0.67)	0.65*** (0.63 - 0.68)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.38)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.00 (0.97 - 1.03)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.85*** (0.82 - 0.88)
Gender (Female=ref)			
Male	0.88*** (0.85 - 0.90)	0.62*** (0.60 - 0.64)	1.31*** (1.28 - 1.35)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.01 (0.96 - 1.07)	1.35*** (1.27 - 1.44)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.85 - 0.95)	1.30*** (1.22 - 1.37)	1.21*** (1.15 - 1.27)
Other	0.87*** (0.81 - 0.94)	1.03 (0.95 - 1.11)	0.96 (0.90 - 1.03)

Education (Less than high school= ref)			
Highschool or higher	0.96** (0.93 - 0.99)	0.80*** (0.78 - 0.83)	0.78*** (0.76 - 0.80)
Number of arrests (0= ref)			
1	0.85*** (0.79 - 0.91)	1.19*** (1.11 - 1.27)	2.73*** (2.60 - 2.86)
2 or more	0.85** (0.76 - 0.95)	0.97 (0.84 - 1.12)	1.09 (0.99 - 1.20)
Employment status (Not employed= ref)			
Employed	1.32*** (1.28 - 1.36)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity (No= ref)			
Yes	1.49*** (1.45 - 1.53)	0.92*** (0.89 - 0.95)	0.65*** (0.63 - 0.67)
Homeless (No= ref)			
Yes	1.31*** (1.25 - 1.38)	1.35*** (1.28 - 1.43)	0.61*** (0.58 - 0.65)
Polysubstance use (no= ref)			
One more	0.99 (0.96 - 1.02)	1.02 (0.99 - 1.06)	0.85*** (0.83 - 0.88)
Two or more	0.98 (0.95 - 1.01)	1.07*** (1.03 - 1.11)	0.95** (0.92 - 0.98)

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

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR.

Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results).

Table 2-F2 Sensitivity analysis that added Waiver 1115 Demonstrations: DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272 RRR (95%CI)	225,272 RRR (95%CI)	225,272 RRR (95%CI)
Expansion	0.84 (0.52 - 1.36)	0.94 (0.58 - 1.52)	1.06 (0.64 - 1.75)
Post expansion	0.70*** (0.66 - 0.74)	0.42*** (0.39 - 0.45)	0.82*** (0.77 - 0.87)
Expansion * Post expansion	1.18*** (1.12 - 1.24)	2.38*** (2.22 - 2.54)	1.31*** (1.25 - 1.38)
Waiver 1115 Demonstrations			
Yes	1.21 (0.97 - 1.50)	1.16 (0.98 - 1.36)	1.02 (0.88 - 1.19)
MAT (No= ref)			
Yes	0.65*** (0.63 - 0.67)	0.33*** (0.32 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.63 - 0.69)	0.38*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.38*** (0.36 - 0.39)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	0.99 (0.96 - 1.03)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.84*** (0.81 - 0.88)
Gender			
Male	0.88*** (0.85 - 0.90)	0.62*** (0.60 - 0.63)	1.31*** (1.28 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02 (0.96 - 1.07)	1.36*** (1.28 - 1.45)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.84 - 0.94)	1.31*** (1.24 - 1.39)	1.21*** (1.15 - 1.27)
Other	0.88*** (0.82 - 0.95)	1.04 (0.96 - 1.12)	0.98 (0.92 - 1.06)
Education			
Highschool or higher	0.96* (0.94 - 0.99)	0.81*** (0.78 - 0.84)	0.78*** (0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83*** (0.78 - 0.89)	1.20*** (1.12 - 1.28)	2.73*** (2.60 - 2.87)
2 or more	0.86* (0.82 - 0.90)	0.96 (0.92 - 1.00)	1.08 (1.04 - 1.12)

	(0.77 - 0.97)	(0.83 - 1.12)	(0.98 - 1.20)
Employment status			
Employed	1.33*** (1.29 - 1.37)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity			
Yes	1.50*** (1.46 - 1.54)	0.91*** (0.89 - 0.94)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.26 - 1.40)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	1.00 (0.97 - 1.03)	1.02 (0.98 - 1.05)	0.85*** (0.82 - 0.87)
Two or more	0.99 (0.95 - 1.02)	1.06** (1.02 - 1.10)	0.94*** (0.91 - 0.97)

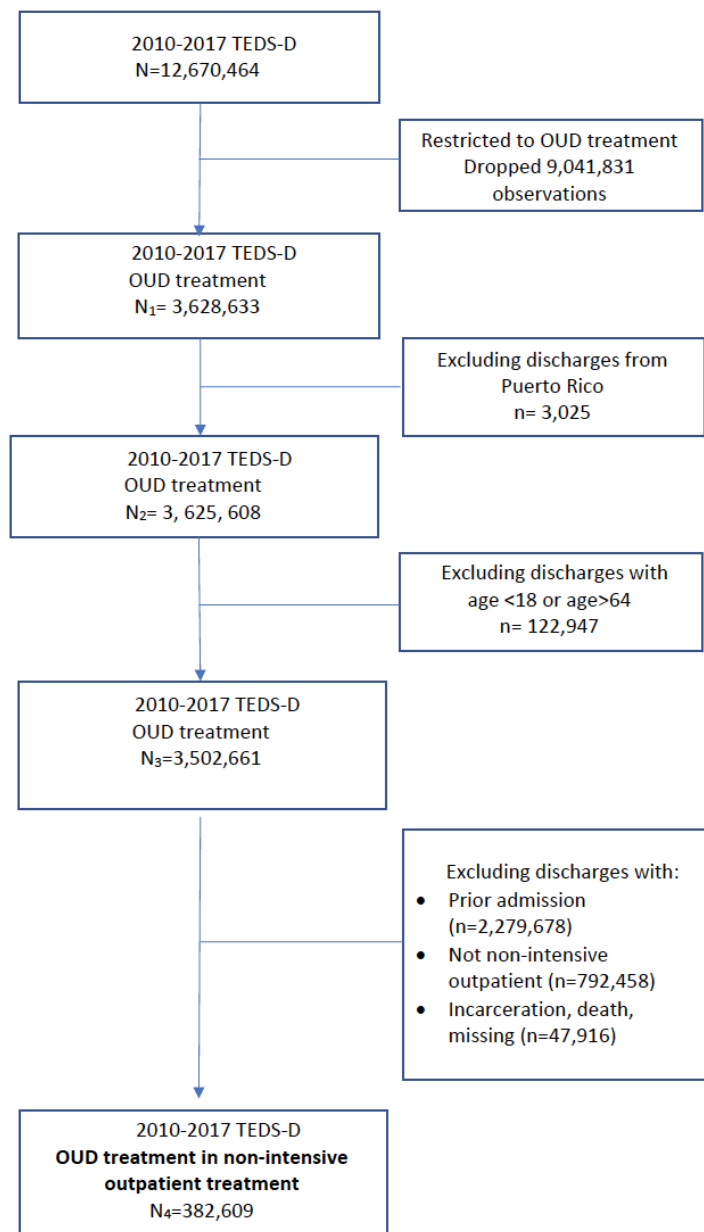
* p<0.05, ** p<0.01, *** p<0.001

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

The associations were also adjusted for year and state fixed effects (Please see appendix for the full results)

Appendix 3-A

Figure 3-A. Flowchart of the study sample



Appendix 3-B

Summary of Medicaid expansion and Section 1115 Demonstration Waiver

Table 3-B. Summary of Medicaid Expansion across states as of 2017

<i>State</i>	<i>Expansion status</i>	<i>Section 1115 Demonstrations: Substance Use Disorders</i>
Alabama	Not adopted	
Florida	Not adopted	
Kansas	Not adopted	
Mississippi	Not adopted	
Missouri	Not adopted	
North Carolina	Not adopted	(11/1/2019)
Oklahoma	Not adopted	
South Carolina	Not adopted	
South Dakota	Not adopted	
Tennessee	Not adopted	
Texas	Not adopted	
Wisconsin	Not adopted	1/1/2014
Wyoming	Not adopted	
Georgia	<i>Not adopted</i> (later adopted on 12/1/20)	
Nebraska	Not adopted (later adopted on 10/1/20)	(7/1/2019)
Idaho	Not adopted (later adopted on 1/1/20)	(4/17/2020)
Utah	Not adopted (later adopted on 1/1/20)	7/1/2002
Maine	Not adopted (later adopted on 1/10/19)	
Virginia	Not adopted (later adopted on 1/1/19)	4/1/2017
Louisiana	7/1/16	(2/1/2018)
Montana	1/1/16	
Alaska	9/1/15	(1/1/2019)
Indiana	2/1/15	2/1/2015
Pennsylvania	1/1/15	10/1/2017
New Hampshire	8/15/14	(7/10/2018)
Michigan	4/1/14	
Arizona	1/1/14	
Arkansas	1/1/14	1/1/2013

California	1/1/14	9/1/2005
Colorado	1/1/14	
Connecticut	1/1/14	
Delaware	1/1/14	1/1/1996
District of Columbia	1/1/14	(1/1/2020)
Hawaii	1/1/14	
Illinois	1/1/14	
Iowa	1/1/14	
Kentucky	1/1/14	(4/1/2019)
Maryland	1/1/14	7/1/1997
Massachusetts	1/1/14	7/1/1997
Minnesota	1/1/14	(10/1/2019)
Nevada	1/1/14	
New Jersey	1/1/14	10/2/2012
New Mexico	1/1/14	(1/1/2019)
New York	1/1/14	(10/1/2019)
North Dakota	1/1/14	
Ohio	1/1/14	(10/1/2019)
Oregon	1/1/14	
Rhode Island	1/1/14	7/1/2009
Vermont	1/1/14	10/1/2005
Washington	1/1/14	1/9/2017
West Virginia	1/1/14	(1/1/2018)

Appendix 3-C

Sensitivity analysis that removing referral source covariate

Table 3-C1. DID model for the adjusted associations between Medicaid expansion and length of stay (without controlling for referral sources)

	DID pooled model	DID Non-MAT	DID MAT
N	228,239	166,465	61,771
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.96*** (2.10 - 4.15)	2.09** (1.27 - 3.45)	3.35*** (2.12 - 5.30)
Expansion	0.98	1.30***	0.52***
After the ACA implementation (2014)	(0.93 - 1.02)	(1.23 - 1.37)	(0.47 - 0.58)
Medicaid expansion			
Expansion	0.96 (0.92 - 1.00)	0.96 (0.92 - 1.01)	1.17*** (1.07 - 1.29)
MAT (No= ref)			
Yes	1.95*** (1.90 - 1.99)		
Frequency of use (No past month use= ref)			
Some use	0.65*** (0.63 - 0.66)	0.61*** (0.59 - 0.63)	0.87*** (0.81 - 0.93)
Daily use	0.57*** (0.55 - 0.58)	0.49*** (0.48 - 0.51)	0.88*** (0.84 - 0.93)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.06*** (1.04 - 1.09)	1.09*** (1.05 - 1.14)
45-64	1.27*** (1.24 - 1.31)	1.28*** (1.24 - 1.32)	1.33*** (1.26 - 1.40)
Gender (Female=ref)			
Male	0.93*** (0.91 - 0.95)	0.93*** (0.91 - 0.95)	0.93*** (0.89 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96 (0.93 - 1.00)	0.97 (0.93 - 1.02)	0.93* (0.88 - 0.99)
Hispanic	1.03 (0.99 - 1.07)	0.97 (0.92 - 1.01)	1.09** (1.03 - 1.16)

Other	1.01 (0.96 - 1.07)	1.01 (0.95 - 1.08)	0.97 (0.87 - 1.09)
Education (Less than high school= ref)			
Highschool or higher	0.96*** (0.94 - 0.98)	0.97** (0.94 - 0.99)	0.96* (0.92 - 1.00)
Number of arrests (0= ref)			
1	1.07*** (1.03 - 1.12)	1.20*** (1.14 - 1.25)	0.75*** (0.69 - 0.82)
2 or more	1.21*** (1.12 - 1.31)	1.17*** (1.07 - 1.28)	0.86 (0.71 - 1.04)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.83*** (0.82 - 0.85)	0.82*** (0.80 - 0.84)	0.88*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.70*** (0.67 - 0.73)	0.72*** (0.68 - 0.76)	0.68*** (0.63 - 0.74)
Polysubstance use (no= ref)			
One more	0.78*** (0.76 - 0.80)	0.77*** (0.75 - 0.79)	0.85*** (0.81 - 0.88)
Two or more	0.72*** (0.70 - 0.74)	0.74*** (0.72 - 0.76)	0.75*** (0.72 - 0.79)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3C-2. DID model for the adjusted associations of Medicaid expansion and treatment completion (without controlling for referral sources)

	DID pooled model	DID non-MAT	DID MAT
N	228,235	166,463	61,769
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.02*** (1.43 - 2.84)	1.78* (1.09 - 2.91)	3.00*** (1.84 - 4.87)
Expansion			
After the ACA implementation (2014)	1.56*** (1.50 - 1.64)	1.40*** (1.33 - 1.47)	2.14*** (1.90 - 2.40)
Medicaid expansion			
Expansion	0.87*** (0.83 - 0.91)	1.06* (1.01 - 1.11)	0.49*** (0.44 - 0.55)
MAT (No= ref)			
Yes	0.74*** (0.72 - 0.76)		
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.65 - 0.69)	0.69*** (0.67 - 0.71)	0.66*** (0.62 - 0.71)
Daily use	0.65*** (0.63 - 0.66)	0.71*** (0.70 - 0.73)	0.53*** (0.50 - 0.56)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.08)	1.06*** (1.04 - 1.09)	1.03 (0.99 - 1.08)
45-64	1.12*** (1.09 - 1.15)	1.20*** (1.16 - 1.25)	0.98 (0.93 - 1.04)
Gender (Female=ref)			
Male	0.95*** (0.94 - 0.97)	0.99 (0.97 - 1.02)	0.81*** (0.78 - 0.85)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.84*** (0.81 - 0.87)	0.97 (0.92 - 1.01)	0.68*** (0.63 - 0.73)
Hispanic	0.86*** (0.83 - 0.89)	0.94* (0.90 - 0.99)	0.78*** (0.73 - 0.84)
Other	0.74*** (0.70 - 0.78)	0.77*** (0.73 - 0.82)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			

Highschool or higher	1.16*** (1.13 - 1.18)	1.13*** (1.10 - 1.16)	1.19*** (1.14 - 1.24)
Number of arrests (0= ref)			
1	1.28*** (1.23 - 1.34)	1.33*** (1.27 - 1.39)	1.11* (1.01 - 1.23)
2 or more	0.84*** (0.77 - 0.91)	0.87** (0.79 - 0.95)	1.08 (0.87 - 1.34)
Employment status (Unemployed= ref)			
Employed	1.02 (1.00 - 1.04)	1.05*** (1.02 - 1.07)	0.98 (0.94 - 1.02)
Comorbidity (No= ref)			
Yes	0.85*** (0.83 - 0.87)	0.81*** (0.79 - 0.83)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.08** (1.03 - 1.12)	1.09** (1.04 - 1.15)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.11*** (1.08 - 1.13)	1.11*** (1.08 - 1.14)	1.03 (0.99 - 1.08)
Two or more	1.21*** (1.18 - 1.24)	1.20*** (1.16 - 1.23)	1.10*** (1.04 - 1.16)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Sensitivity analysis with additional covariates

Table 3D-1. Sensitivity analysis with added covariates for the 2WFE model for the adjusted associations between Medicaid expansion and *length of stay*

	2 ways fixed effect pooled model	2 ways fixed effect Non-MAT	2 ways fixed effect MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.94** (0.90 - 0.98)	0.95 (0.91 - 1.00)	1.15** (1.04 - 1.26)
MAT (No= ref)			
Yes	2.22*** (2.16 - 2.27)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.04)	0.87*** (0.83 - 0.92)
Institutional referral	1.04* (1.01 - 1.08)	1.21*** (1.17 - 1.26)	0.77*** (0.72 - 0.83)
Court/criminal justice	1.87*** (1.82 - 1.92)	2.14*** (2.08 - 2.20)	0.74*** (0.69 - 0.81)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.70 - 0.74)	0.70*** (0.68 - 0.73)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.80 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.04 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.30*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.31*** (1.24 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.91)	0.89*** (0.87 - 0.91)	0.92*** (0.89 - 0.95)

Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94** (0.89 - 0.98)	0.92** (0.87 - 0.98)
Hispanic	1.01 (0.98 - 1.05)	0.94** (0.90 - 0.98)	1.09** (1.02 - 1.16)
Other	1.00 (0.95 - 1.06)	0.99 (0.93 - 1.06)	0.99 (0.89 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.97 (0.93 - 1.01)	1.04 (0.99 - 1.09)	0.79*** (0.73 - 0.86)
2 or more	1.18*** (1.09 - 1.28)	1.17*** (1.07 - 1.28)	0.86 (0.72 - 1.04)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.86)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.90*** (0.87 - 0.92)	0.89*** (0.86 - 0.93)
Homeless (No= ref)			
Yes	0.74*** (0.70 - 0.77)	0.77*** (0.73 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.80*** (0.78 - 0.81)	0.80*** (0.78 - 0.82)	0.86*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.74)	0.76*** (0.74 - 0.78)	0.76*** (0.72 - 0.80)
Unemployment rate			
Unemployment rate	0.98 (0.96 - 1.00)	0.95*** (0.92 - 0.97)	1.03 (0.99 - 1.07)
PMDP (No= ref)			
Yes	1.06* (1.01 - 1.12)	1.00 (0.92 - 1.07)	1.39*** (1.27 - 1.52)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-D2. Sensitivity with added covariates for the DID model for the adjusted association between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,272	164,420	60,849
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.87*** (2.04 - 4.05)	1.98** (1.19 - 3.28)	3.40*** (2.15 - 5.39)
Expansion			
After the ACA implementation (2014)	0.81** (0.71 - 0.92)	0.91 (0.78 - 1.06)	0.53*** (0.41 - 0.68)
Medicaid expansion			
Expansion	0.95* (0.91 - 1.00)	0.98 (0.93 - 1.03)	1.15** (1.05 - 1.27)
MAT (No= ref)			
Yes	2.23*** (2.18 - 2.29)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.98 - 1.05)	0.87*** (0.83 - 0.92)
Institutional referral	1.05** (1.02 - 1.09)	1.22*** (1.17 - 1.27)	0.79*** (0.73 - 0.85)
Court/criminal justice	1.88*** (1.83 - 1.94)	2.16*** (2.10 - 2.23)	0.74*** (0.68 - 0.80)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.69 - 0.74)	0.70*** (0.68 - 0.72)	0.84*** (0.78 - 0.90)
Daily use	0.67*** (0.65 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.79 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.10)	1.07*** (1.05 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.30*** (1.27 - 1.34)	1.32*** (1.27 - 1.37)	1.30*** (1.24 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.92)	0.89*** (0.87 - 0.91)	0.93*** (0.89 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94**	0.94**	0.93*

	(0.91 - 0.98)	(0.89 - 0.98)	(0.87 - 0.99)
Hispanic	1.01	0.94**	1.08**
	(0.97 - 1.05)	(0.89 - 0.98)	(1.02 - 1.15)
Other	1.01	1.00	0.99
	(0.95 - 1.07)	(0.94 - 1.07)	(0.89 - 1.11)
Education (Less than high school= ref)			
Highschool or higher	0.98*	1.00	0.96*
	(0.96 - 1.00)	(0.98 - 1.03)	(0.92 - 0.99)
Number of arrests (0= ref)			
1	0.96	1.04	0.79***
	(0.92 - 1.00)	(0.99 - 1.10)	(0.72 - 0.86)
2 or more	1.20***	1.19***	0.86
	(1.10 - 1.29)	(1.08 - 1.30)	(0.71 - 1.04)
Employment status (Unemployed= ref)			
Employed	0.80***	0.79***	0.83***
	(0.78 - 0.82)	(0.77 - 0.81)	(0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88***	0.89***	0.89***
	(0.86 - 0.90)	(0.87 - 0.91)	(0.86 - 0.93)
Homeless (No= ref)			
Yes	0.73***	0.76***	0.70***
	(0.70 - 0.76)	(0.72 - 0.81)	(0.64 - 0.75)
Polysubstance use (no= ref)			
One more	0.79***	0.79***	0.85***
	(0.77 - 0.81)	(0.77 - 0.82)	(0.82 - 0.89)
Two or more	0.72***	0.75***	0.76***
	(0.70 - 0.74)	(0.73 - 0.78)	(0.72 - 0.80)
Unemployment rate			
Unemployment rate	0.97**	0.94***	1.03
	(0.95 - 0.99)	(0.91 - 0.96)	(0.99 - 1.07)
PMDP (No= ref)			
Yes	1.07*	1.00	1.40***
	(1.01 - 1.13)	(0.92 - 1.08)	(1.28 - 1.53)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-D3. Sensitivity analysis with added covariates for the 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	229,288	168,163	61,122
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion	0.84***	1.03	0.47***
Expansion	(0.81 - 0.88)	(0.99 - 1.09)	(0.42 - 0.52)
MAT (No= ref)			
Yes	0.86*** (0.84 - 0.88)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.14*** (1.08 - 1.21)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.15*** (1.06 - 1.24)
Court/criminal justice	2.03*** (1.98 - 2.09)	2.00*** (1.95 - 2.06)	1.89*** (1.73 - 2.06)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.71 - 0.76)	0.76*** (0.73 - 0.78)	0.70*** (0.65 - 0.76)
Daily use	0.77*** (0.75 - 0.79)	0.85*** (0.83 - 0.88)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.08)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	0.99 (0.93 - 1.05)
Gender (Female=ref)			
Male	0.93*** (0.92 - 0.95)	0.97** (0.95 - 0.99)	0.81*** (0.78 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			

Non-Hispanic Black	0.82*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.89)	0.92*** (0.88 - 0.96)	0.81*** (0.75 - 0.87)
Other	0.73*** (0.69 - 0.77)	0.76*** (0.72 - 0.81)	0.69*** (0.61 - 0.78)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.19*** (1.13 - 1.24)	1.03 (0.94 - 1.14)
2 or more	0.84*** (0.77 - 0.91)	0.89** (0.81 - 0.97)	1.02 (0.82 - 1.28)
Employment status (Unemployed= ref)			
Employed	1.03* (1.00 - 1.05)	1.06*** (1.03 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.88 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 1.00)
Homeless (No= ref)			
Yes	1.11*** (1.06 - 1.15)	1.14*** (1.08 - 1.20)	1.03 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.12*** (1.10 - 1.14)	1.14*** (1.11 - 1.17)	1.02 (0.98 - 1.07)
Two or more	1.21*** (1.18 - 1.24)	1.22*** (1.18 - 1.25)	1.06* (1.01 - 1.12)
Unemployment rate			
Unemployment rate	0.98* (0.96 - 1.00)	0.96** (0.94 - 0.98)	1.06* (1.01 - 1.11)
PMDP (No= ref)			
Yes	1.11*** (1.05 - 1.18)	1.13** (1.05 - 1.22)	1.17** (1.05 - 1.30)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-D4. Sensitivity with added covariates for the DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,268	164,418	60,847
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.02*** (1.43 - 2.85)	1.79* (1.09 - 2.93)	3.18*** (1.94 - 5.19)
Expansion			
After the ACA implementation (2014)	1.53*** (1.34 - 1.74)	1.28** (1.10 - 1.49)	2.87*** (2.18 - 3.78)
Medicaid expansion			
Expansion	0.83*** (0.79 - 0.86)	1.02 (0.97 - 1.07)	0.47*** (0.42 - 0.52)
MAT (No= ref)			
Yes	0.87*** (0.85 - 0.89)		
Referral sources			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.14*** (1.08 - 1.21)
Institutional referral	1.31*** (1.27 - 1.35)	1.32*** (1.28 - 1.37)	1.16*** (1.08 - 1.26)
Court/criminal justice	2.05*** (2.00 - 2.11)	2.03*** (1.97 - 2.09)	1.89*** (1.73 - 2.07)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.72 - 0.77)	0.77*** (0.75 - 0.79)	0.70*** (0.65 - 0.76)
Daily use	0.79*** (0.77 - 0.81)	0.88*** (0.85 - 0.90)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.09)
45-64	1.14*** (1.11 - 1.17)	1.23*** (1.18 - 1.27)	0.99 (0.94 - 1.05)
Gender (Female=ref)			
Male	0.93*** (0.91 - 0.95)	0.96*** (0.94 - 0.98)	0.81*** (0.78 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			

Non-Hispanic Black	0.82*** (0.79 - 0.85)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.88)	0.92*** (0.88 - 0.97)	0.80*** (0.75 - 0.86)
Other	0.74*** (0.70 - 0.78)	0.78*** (0.73 - 0.83)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.16*** (1.11 - 1.21)	1.20*** (1.14 - 1.26)	1.03 (0.94 - 1.14)
2 or more	0.83*** (0.77 - 0.90)	0.88** (0.80 - 0.97)	1.03 (0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.04 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.87 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 1.00)
Homeless (No= ref)			
Yes	1.11*** (1.06 - 1.16)	1.15*** (1.09 - 1.21)	1.03 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.13*** (1.10 - 1.15)	1.14*** (1.11 - 1.17)	1.02 (0.98 - 1.07)
Two or more	1.22*** (1.19 - 1.25)	1.22*** (1.19 - 1.26)	1.07* (1.01 - 1.13)
Unemployment rate			
Unemployment rate	1.00 (0.98 - 1.02)	0.98 (0.96 - 1.01)	1.06** (1.02 - 1.11)
PMDP (No= ref)			
Yes	1.13*** (1.07 - 1.20)	1.17*** (1.08 - 1.26)	1.18** (1.06 - 1.32)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Appendix 3-E

Sensitivity with lagged model

Table 3-E1. Sensitivity with lagged model for the DID model for the adjusted association between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,272	164,420	60,849
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Expansion states	2.87*** (2.03 - 4.05)	2.07** (1.25 - 3.44)	3.34*** (2.08 - 5.38)
Expansion year (2014)	2.15*** (2.02 - 2.29)	2.36*** (2.20 - 2.53)	1.59*** (1.33 - 1.91)
Expansion * Post expansion year 0	0.57*** (0.53 - 0.61)	0.57*** (0.53 - 0.62)	0.61*** (0.51 - 0.74)
Post expansion year 1	0.39*** (0.36 - 0.42)	0.36*** (0.33 - 0.40)	0.56*** (0.45 - 0.70)
Expansion* Post expansion year 1	2.48*** (2.26 - 2.73)	3.00*** (2.69 - 3.34)	1.45** (1.15 - 1.83)
Post expansion year 2	1.49*** (1.38 - 1.62)	1.57*** (1.43 - 1.72)	1.38*** (1.14 - 1.66)
Expansion* Post expansion year 2	0.62*** (0.57 - 0.68)	0.59*** (0.53 - 0.65)	0.72** (0.59 - 0.88)
Post expansion year 3	0.70*** (0.66 - 0.74)	0.99 (0.93 - 1.07)	0.25*** (0.21 - 0.29)
Expansion* Post expansion year 3	1.29*** (1.20 - 1.40)	0.93 (0.85 - 1.02)	3.58*** (3.04 - 4.23)
MAT (No= ref)			
Yes	2.23*** (2.17 - 2.28)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.98 - 1.05)	0.88*** (0.83 - 0.93)
Institutional referral	1.05** (1.01 - 1.08)	1.22*** (1.17 - 1.26)	0.79*** (0.73 - 0.85)
Court/criminal justice	1.88*** (1.83 - 1.93)	2.17*** (2.11 - 2.23)	0.73*** (0.68 - 0.80)
Frequency of use (No past month use= ref)			
Some use	0.71*** (0.69 - 0.74)	0.70*** (0.68 - 0.72)	0.85*** (0.79 - 0.91)
Daily use	0.67***	0.62***	0.86***

	(0.66 - 0.69)	(0.60 - 0.64)	(0.81 - 0.91)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.05 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.30*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.30*** (1.23 - 1.37)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.92)	0.89*** (0.87 - 0.91)	0.93*** (0.90 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94* (0.89 - 0.99)	0.94* (0.88 - 1.00)
Hispanic	1.01 (0.97 - 1.05)	0.94** (0.89 - 0.98)	1.09** (1.02 - 1.16)
Other	1.00 (0.95 - 1.06)	1.00 (0.94 - 1.07)	0.98 (0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 1.00)
Number of arrests (0= ref)			
1	0.96 (0.92 - 1.00)	1.04 (0.99 - 1.09)	0.79*** (0.72 - 0.86)
2 or more	1.20*** (1.11 - 1.30)	1.17*** (1.07 - 1.28)	0.89 (0.73 - 1.07)
Employment status (Unemployed= ref)			
Employed	0.80*** (0.78 - 0.82)	0.79*** (0.77 - 0.81)	0.84*** (0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.89*** (0.87 - 0.92)	0.89*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.73*** (0.70 - 0.76)	0.77*** (0.72 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.79*** (0.78 - 0.81)	0.79*** (0.77 - 0.82)	0.85*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.75)	0.76*** (0.73 - 0.78)	0.76*** (0.72 - 0.80)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-E2. Sensitivity with lagged model for the DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	223,557	163,159	60,395
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion states	2.15*** (1.52 - 3.06)	1.91* (1.16 - 3.15)	3.10*** (1.87 - 5.13)
Expansion year (2014)	0.61*** (0.57 - 0.65)	0.64*** (0.60 - 0.68)	0.50*** (0.41 - 0.61)
Expansion * Post expansion year 0	1.61*** (1.51 - 1.73)	1.64*** (1.52 - 1.76)	1.78*** (1.45 - 2.19)
Post expansion year 1	1.29*** (1.19 - 1.39)	1.23*** (1.13 - 1.33)	2.14*** (1.67 - 2.74)
Expansion* Post expansion year 1	0.68*** (0.62 - 0.75)	0.75*** (0.68 - 0.83)	0.36*** (0.28 - 0.47)
Post expansion year 2	1.47*** (1.36 - 1.58)	1.47*** (1.36 - 1.60)	1.45** (1.16 - 1.81)
Expansion* Post expansion year 2	0.72*** (0.66 - 0.79)	0.72*** (0.65 - 0.79)	0.78* (0.61 - 0.99)
Post expansion year 3	1.93*** (1.81 - 2.05)	1.56*** (1.46 - 1.67)	2.15*** (1.80 - 2.57)
Expansion* Post expansion year 3	0.59*** (0.54 - 0.64)	0.74*** (0.67 - 0.81)	0.54*** (0.44 - 0.65)
MAT (No= ref)			
Yes	0.87*** (0.85 - 0.89)		
Referral sources			
Healthcare provider referral	1.08*** (1.05 - 1.11)	1.06*** (1.03 - 1.10)	1.15*** (1.08 - 1.22)
Institutional referral	1.32*** (1.28 - 1.37)	1.34*** (1.29 - 1.39)	1.18*** (1.09 - 1.27)
Court/criminal justice	2.08*** (2.02 - 2.13)	2.04*** (1.98 - 2.10)	1.91*** (1.75 - 2.09)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.72 - 0.77)	0.77*** (0.74 - 0.79)	0.70*** (0.65 - 0.75)
Daily use	0.78*** (0.76 - 0.80)	0.87*** (0.84 - 0.89)	0.58*** (0.54 - 0.61)
Age (18-29= ref)			
30-44	1.06***	1.07***	1.04

	(1.04 - 1.09)	(1.04 - 1.10)	(0.99 - 1.09)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	1.00 (0.94 - 1.06)
Gender (Female=ref)			
Male	0.92*** (0.91 - 0.94)	0.96** (0.94 - 0.98)	0.80*** (0.77 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.82*** (0.78 - 0.85)	0.93** (0.89 - 0.98)	0.67*** (0.62 - 0.72)
Hispanic	0.85*** (0.82 - 0.89)	0.92** (0.88 - 0.97)	0.80*** (0.74 - 0.85)
Other	0.76*** (0.72 - 0.80)	0.79*** (0.74 - 0.84)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			
Highschool or higher	1.18*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.20*** (1.14 - 1.26)	1.03 (0.94 - 1.14)
2 or more	0.83*** (0.77 - 0.90)	0.88** (0.81 - 0.97)	1.04 (0.84 - 1.30)
Employment status (Unemployed= ref)			
Employed	1.03* (1.00 - 1.05)	1.06*** (1.03 - 1.09)	0.97 (0.92 - 1.01)
Comorbidity (No= ref)			
Yes	0.90*** (0.88 - 0.92)	0.87*** (0.85 - 0.89)	0.96 (0.92 - 1.00)
Homeless (No= ref)			
Yes	1.10*** (1.05 - 1.15)	1.14*** (1.08 - 1.21)	1.01 (0.93 - 1.10)
Polysubstance use (no= ref)			
One more	1.11*** (1.08 - 1.13)	1.13*** (1.10 - 1.16)	1.02 (0.98 - 1.07)
Two or more	1.20*** (1.17 - 1.23)	1.21*** (1.17 - 1.24)	1.07* (1.01 - 1.13)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Sensitivity analysis with added Section 1115 Demonstration Waiver

Table 3-F1. Sensitivity analysis added Waiver 1115 Demonstrations: Two-ways fixed effects model for the adjusted associations between Medicaid expansion and treatment length of stay

	2 ways fixed effect pooled model	Non-MAT	MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.93** (0.90 - 0.98)	0.93** (0.89 - 0.98)	1.15** (1.05 - 1.27)
Waiver 1115 Demonstration			
Yes	0.93 (0.85 - 1.02)	0.75*** (0.65 - 0.87)	1.29*** (1.14 - 1.46)
MAT (No= ref)			
Yes	2.21*** (2.16 - 2.27)		
Referral sources (Self- referral= ref)			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.04)	0.87*** (0.83 - 0.92)
Institutional referral	1.04* (1.01 - 1.08)	1.21*** (1.17 - 1.26)	0.78*** (0.72 - 0.84)
Court/criminal justice	1.87*** (1.82 - 1.92)	2.14*** (2.08 - 2.20)	0.74*** (0.69 - 0.81)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.70 - 0.74)	0.70*** (0.68 - 0.73)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.80 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.04 - 1.10)	1.09*** (1.04 - 1.13)

45-64	1.31*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.31*** (1.24 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.91)	0.89*** (0.87 - 0.91)	0.92*** (0.89 - 0.95)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94** (0.89 - 0.98)	0.92* (0.87 - 0.98)
Hispanic	1.01 (0.98 - 1.05)	0.94* (0.90 - 0.99)	1.09** (1.02 - 1.15)
Other	1.00 (0.95 - 1.06)	1.00 (0.94 - 1.06)	0.98 (0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.97 (0.93 - 1.01)	1.04 (0.99 - 1.09)	0.79*** (0.73 - 0.86)
2 or more	1.18*** (1.09 - 1.28)	1.16*** (1.06 - 1.27)	0.88 (0.73 - 1.06)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.86)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.90*** (0.87 - 0.92)	0.89*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.74*** (0.70 - 0.77)	0.77*** (0.73 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.79*** (0.78 - 0.81)	0.80*** (0.78 - 0.82)	0.86*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.74)	0.76*** (0.73 - 0.78)	0.76*** (0.72 - 0.80)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-F2. Sensitivity analysis added Waiver 1115 Demonstrations: 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.85*** (0.81 - 0.88)	1.02 (0.97 - 1.07)	0.49*** (0.44 - 0.54)
Waiver 1115 Demonstration			
Yes	0.84*** (0.77 - 0.92)	0.83* (0.72 - 0.96)	0.93 (0.80 - 1.07)
MAT (No= ref)			
Yes	0.86*** (0.84 - 0.88)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.15*** (1.08 - 1.21)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.15*** (1.07 - 1.24)
Court/criminal justice	2.03*** (1.98 - 2.09)	2.00*** (1.94 - 2.06)	1.89*** (1.73 - 2.06)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.71 - 0.76)	0.76*** (0.73 - 0.78)	0.70*** (0.65 - 0.76)
Daily use	0.77*** (0.75 - 0.79)	0.85*** (0.83 - 0.88)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.09)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	0.99 (0.93 - 1.05)
Gender (Female=ref)			
Male	0.93***	0.97**	0.81***

	(0.92 - 0.95)	(0.95 - 0.99)	(0.78 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.83*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.89)	0.92*** (0.88 - 0.97)	0.81*** (0.75 - 0.87)
Other	0.73*** (0.69 - 0.77)	0.76*** (0.72 - 0.81)	0.69*** (0.61 - 0.78)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.19*** (1.13 - 1.24)	1.04 (0.94 - 1.14)
2 or more	0.84*** (0.78 - 0.91)	0.89* (0.81 - 0.97)	1.03 (0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.03 - 1.09)	0.98 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.88 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.10*** (1.06 - 1.15)	1.13*** (1.08 - 1.20)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.12*** (1.09 - 1.14)	1.13*** (1.11 - 1.16)	1.02 (0.98 - 1.07)
Two or more	1.21*** (1.18 - 1.25)	1.22*** (1.18 - 1.25)	1.07* (1.01 - 1.13)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Appendix 3-G

Sensitivity analysis for discharges with more than one treatment episode

Table 3-G1. 2WFE model for the adjusted associations between Medicaid expansion and **length of stay**

	2 ways fixed effect pooled model	2 ways fixed effect Non-MAT	2 ways fixed effect MAT
N	518,154	326,027	192,127
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
<hr/>			
Medicaid expansion			
Expansion	0.96* (0.93 - 1.00)	0.89*** (0.85 - 0.93)	1.11** (1.04 - 1.19)
MAT (No= ref)			
Yes	2.07*** (2.04 - 2.10)		
Referral sources			
Healthcare provider referral	0.83*** (0.82 - 0.85)	0.95*** (0.93 - 0.97)	0.79*** (0.77 - 0.81)
Institutional referral	0.99 (0.97 - 1.01)	1.15*** (1.12 - 1.18)	0.86*** (0.83 - 0.90)
Court/criminal justice	1.34*** (1.32 - 1.36)	1.60*** (1.56 - 1.63)	0.72*** (0.69 - 0.75)
Frequency of use (No past month use= ref)			
Some use	0.68*** (0.67 - 0.69)	0.64*** (0.63 - 0.65)	0.80*** (0.77 - 0.82)
Daily use	0.69*** (0.68 - 0.70)	0.59*** (0.58 - 0.61)	0.82*** (0.80 - 0.84)
Age (18-29= ref)			
30-44	1.11*** (1.09 - 1.12)	1.09*** (1.07 - 1.11)	1.13*** (1.11 - 1.16)
45-64	1.43*** (1.40 - 1.45)	1.39*** (1.36 - 1.42)	1.48*** (1.44 - 1.53)
Gender (Female=ref)			
Male	0.92***	0.92***	0.92***

	(0.91 - 0.93)	(0.90 - 0.93)	(0.90 - 0.94)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94*** (0.92 - 0.97)	0.88*** (0.85 - 0.91)	1.01 (0.98 - 1.05)
Hispanic	1.06*** (1.04 - 1.08)	0.97 (0.95 - 1.00)	1.14*** (1.11 - 1.18)
Other	0.91*** (0.88 - 0.94)	0.90*** (0.87 - 0.94)	0.92** (0.87 - 0.97)
Education (Less than high school= ref)			
Highschool or higher	1.02* (1.00 - 1.03)	1.05*** (1.03 - 1.07)	0.97* (0.95 - 1.00)
Number of arrests (0= ref)			
1	0.91*** (0.89 - 0.93)	0.97 (0.94 - 1.00)	0.84*** (0.81 - 0.88)
2 or more	1.15*** (1.08 - 1.21)	1.10** (1.03 - 1.18)	1.04 (0.93 - 1.17)
Employment status (Unemployed= ref)			
Employed	0.88*** (0.86 - 0.89)	0.87*** (0.85 - 0.88)	0.88*** (0.86 - 0.90)
Comorbidity (No= ref)			
Yes	0.97*** (0.96 - 0.99)	1.00 (0.98 - 1.02)	0.97** (0.95 - 0.99)
Homeless (No= ref)			
Yes	0.76*** (0.74 - 0.78)	0.77*** (0.75 - 0.80)	0.77*** (0.75 - 0.80)
Polysubstance use (no= ref)			
One more	0.92*** (0.90 - 0.93)	0.95*** (0.94 - 0.97)	0.90*** (0.88 - 0.92)
Two or more	0.88*** (0.87 - 0.89)	0.96*** (0.94 - 0.98)	0.80*** (0.78 - 0.82)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-G2. DID model for the adjusted associations between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	503,363	313,253	190,110
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat	2.41***	1.86*	2.88***
Expansion states	(1.76 - 3.29)	(1.13 - 3.07)	(1.94 - 4.29)
Expansion	0.98	1.20***	0.72***
After the ACA implementation (2014)	(0.94 - 1.02)	(1.14 - 1.26)	(0.67 - 0.77)
Medicaid expansion	0.99	0.92***	1.13***
Medicaid expansion	(0.95 - 1.03)	(0.88 - 0.97)	(1.06 - 1.21)
MAT (No= ref)	2.08***		
Yes	(2.05 - 2.11)		
Referral sources			
Healthcare provider referral	0.83***	0.95***	0.80***
	(0.81 - 0.84)	(0.93 - 0.97)	(0.78 - 0.82)
Institutional referral	1.00	1.15***	0.88***
	(0.97 - 1.02)	(1.12 - 1.18)	(0.85 - 0.92)
Court/criminal justice	1.35***	1.61***	0.72***
	(1.33 - 1.37)	(1.58 - 1.65)	(0.69 - 0.75)
Frequency of use (No past month use= ref)			
Some use	0.68***	0.64***	0.80***
	(0.67 - 0.69)	(0.63 - 0.65)	(0.77 - 0.82)
Daily use	0.69***	0.59***	0.82***
	(0.68 - 0.70)	(0.58 - 0.61)	(0.80 - 0.85)
Age (18-29= ref)			
30-44	1.11***	1.10***	1.14***
	(1.09 - 1.13)	(1.08 - 1.12)	(1.11 - 1.17)
45-64	1.43***	1.39***	1.49***
	(1.40 - 1.45)	(1.36 - 1.42)	(1.44 - 1.53)
Gender (Female=ref)			
Male	0.93***	0.92***	0.93***
	(0.92 - 0.94)	(0.91 - 0.94)	(0.91 - 0.94)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	0.95***	0.89***	1.01

	(0.93 - 0.97)	(0.86 - 0.92)	(0.98 - 1.05)
Hispanic	1.06***	0.97	1.14***
	(1.04 - 1.08)	(0.95 - 1.00)	(1.11 - 1.18)
Other	0.91***	0.91***	0.92**
	(0.88 - 0.95)	(0.87 - 0.95)	(0.87 - 0.97)
Education (Less than high school= ref)			
Highschool or higher	1.01*	1.05***	0.97*
	(1.00 - 1.03)	(1.03 - 1.07)	(0.95 - 1.00)
Number of arrests (0= ref)			
1	0.92***	0.99	0.84***
	(0.89 - 0.94)	(0.95 - 1.02)	(0.81 - 0.88)
2 or more	1.17***	1.13**	1.05
	(1.10 - 1.24)	(1.05 - 1.21)	(0.94 - 1.17)
Employment status (Unemployed= ref)			
Employed	0.89***	0.88***	0.88***
	(0.87 - 0.90)	(0.86 - 0.89)	(0.86 - 0.90)
Comorbidity (No= ref)			
Yes	0.98**	1.01	0.97*
	(0.97 - 0.99)	(0.99 - 1.02)	(0.95 - 0.99)
Homeless (No= ref)			
Yes	0.76***	0.77***	0.77***
	(0.74 - 0.78)	(0.75 - 0.80)	(0.74 - 0.80)
Polysubstance use (no= ref)			
One more	0.91***	0.95***	0.90***
	(0.90 - 0.93)	(0.93 - 0.97)	(0.88 - 0.92)
Two or more	0.88***	0.96***	0.79***
	(0.86 - 0.89)	(0.94 - 0.98)	(0.77 - 0.82)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-G3. 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	518,146	326,025	192,121
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion	0.87***	1.10***	0.52***
Expansion	(0.84 - 0.90)	(1.06 - 1.15)	(0.48 - 0.55)
MAT (No= ref)			
Yes	0.78*** (0.77 - 0.79)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.38*** (1.35 - 1.40)	1.32*** (1.29 - 1.35)	1.42*** (1.39 - 1.46)
Institutional referral	1.30*** (1.27 - 1.33)	1.32*** (1.28 - 1.35)	1.21*** (1.16 - 1.26)
Court/criminal justice	2.01*** (1.97 - 2.04)	1.99*** (1.95 - 2.03)	1.73*** (1.66 - 1.80)
Frequency of use (No past month use= ref)			
Some use	0.66*** (0.65 - 0.68)	0.69*** (0.67 - 0.70)	0.62*** (0.60 - 0.65)
Daily use	0.69*** (0.68 - 0.70)	0.86*** (0.84 - 0.87)	0.51*** (0.50 - 0.52)
Age (18-29= ref)			
30-44	1.05*** (1.04 - 1.07)	1.08*** (1.06 - 1.10)	1.00 (0.97 - 1.03)
45-64	1.17*** (1.15 - 1.20)	1.27*** (1.24 - 1.30)	1.01 (0.98 - 1.04)
Gender (Female=ref)			
Male	0.90*** (0.89 - 0.91)	0.93*** (0.92 - 0.95)	0.84*** (0.83 - 0.86)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96**	1.13***	0.77***

	(0.94 - 0.99)	(1.10 - 1.17)	(0.74 - 0.80)
Hispanic	0.86***	0.91***	0.79***
	(0.84 - 0.88)	(0.89 - 0.94)	(0.76 - 0.82)
Other	0.79***	0.84***	0.69***
	(0.76 - 0.82)	(0.81 - 0.88)	(0.65 - 0.74)
Education (Less than high school= ref)			
Highschool or higher	1.19***	1.17***	1.20***
	(1.16 - 1.21)	(1.14 - 1.20)	(1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15***	1.19***	1.04
	(1.10 - 1.20)	(1.13 - 1.24)	(0.94 - 1.14)
2 or more	0.84***	0.89*	1.03
	(0.78 - 0.91)	(0.81 - 0.97)	(0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.11***	1.12***	1.10***
	(1.10 - 1.13)	(1.10 - 1.14)	(1.07 - 1.12)
Comorbidity (No= ref)			
Yes	0.88***	0.87***	0.92***
	(0.87 - 0.89)	(0.86 - 0.89)	(0.90 - 0.94)
Homeless (No= ref)			
Yes	0.98	0.98	0.98
	(0.96 - 1.01)	(0.95 - 1.01)	(0.94 - 1.02)
Polysubstance use (no= ref)			
One more	0.97***	1.00	0.91***
	(0.95 - 0.98)	(0.98 - 1.01)	(0.89 - 0.94)
Two or more	0.99	1.02*	0.93***
	(0.97 - 1.00)	(1.00 - 1.04)	(0.90 - 0.95)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 3-G4. DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	503,355	313,251	190,104
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.79*** (1.96 - 3.98)	2.95*** (1.74 - 4.99)	3.28*** (2.03 - 5.30)
Expansion			
After the ACA implementation (2014)	1.40*** (1.34 - 1.45)	1.26*** (1.20 - 1.31)	1.76*** (1.63 - 1.90)
Medicaid expansion			
Expansion	0.89*** (0.86 - 0.92)	1.14*** (1.09 - 1.19)	0.53*** (0.49 - 0.57)
MAT (No= ref)			
Yes	0.78*** (0.77 - 0.79)		
Referral sources			
Healthcare provider referral	1.38*** (1.36 - 1.41)	1.32*** (1.30 - 1.35)	1.43*** (1.39 - 1.47)
Institutional referral	1.29*** (1.26 - 1.32)	1.30*** (1.27 - 1.34)	1.21*** (1.16 - 1.26)
Court/criminal justice	2.01*** (1.97 - 2.04)	1.99*** (1.95 - 2.03)	1.73*** (1.66 - 1.81)
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.66 - 0.68)	0.70*** (0.68 - 0.71)	0.62*** (0.60 - 0.64)
Daily use	0.70*** (0.69 - 0.71)	0.88*** (0.86 - 0.89)	0.51*** (0.50 - 0.52)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.07)	1.08*** (1.06 - 1.10)	1.00 (0.98 - 1.03)
45-64	1.18*** (1.15 - 1.20)	1.28*** (1.25 - 1.31)	1.01 (0.98 - 1.05)
Gender (Female=ref)			
Male	0.89*** (0.88 - 0.91)	0.93*** (0.91 - 0.94)	0.84*** (0.82 - 0.86)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96**	1.13***	0.77***

	(0.94 - 0.99)	(1.10 - 1.17)	(0.74 - 0.80)
Hispanic	0.86***	0.91***	0.79***
	(0.84 - 0.88)	(0.88 - 0.93)	(0.76 - 0.82)
Other	0.79***	0.85***	0.69***
	(0.76 - 0.82)	(0.81 - 0.89)	(0.65 - 0.74)
Education (Less than high school= ref)			
Highschool or higher	1.11***	1.12***	1.10***
	(1.09 - 1.13)	(1.10 - 1.14)	(1.07 - 1.12)
Number of arrests (0= ref)			
1	1.03	1.07***	0.93**
	(1.00 - 1.06)	(1.04 - 1.11)	(0.89 - 0.98)
2 or more	0.76***	0.79***	0.85*
	(0.72 - 0.81)	(0.74 - 0.85)	(0.74 - 0.96)
Employment status (Unemployed= ref)			
Employed	1.02*	1.05***	0.99
	(1.00 - 1.03)	(1.03 - 1.07)	(0.97 - 1.02)
Comorbidity (No= ref)			
Yes	0.88***	0.87***	0.92***
	(0.87 - 0.89)	(0.86 - 0.89)	(0.90 - 0.94)
Homeless (No= ref)			
Yes	0.98	0.99	0.98
	(0.96 - 1.01)	(0.96 - 1.02)	(0.94 - 1.02)
Polysubstance use (no= ref)			
One more	0.97***	0.99	0.91***
	(0.95 - 0.98)	(0.97 - 1.01)	(0.89 - 0.94)
Two or more	0.98*	1.01	0.92***
	(0.96 - 1.00)	(0.99 - 1.03)	(0.90 - 0.95)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

VITA

Education

Time	Degrees/ Program	University/Institute
2017-2021	Health Behavior and Policy Doctoral program	Virginia Commonwealth University, US
2016-2017	NIDA-Humphrey Fellowship in Substance Abuse Education, Treatment and Prevention	Virginia Commonwealth University and Johns Hopkins University, US
2012-2013	Master of Public Health	The University of Queensland, Australia
2008-2010	Social Science Training and Research (STAR) fellowship	Mailman School of Public Health, Columbia University and Hanoi Medical University. Funded by the U.S National Institute of Health (NIH)
2004-2008	Bachelor of Public Health	Hanoi Medical University, Vietnam

Working experience/ Professional development

08/2017 – Current	Department of Health Behavior and Policy, Virginia Commonwealth University (VCU)
Position	Graduate research assistant (GRA)
Description	<p>1. Working as a GRA on a 5-year (2017-2021) evaluation project of Addiction Recovery Treatment Services (ARTS), and Medicaid expansion evaluation in Virginia</p> <ul style="list-style-type: none"> • Co-designing ARTS member survey questionnaire • Conducting data analysis using member survey, linking to Medicaid claim tracking database (STATA, SAS, Excel), assisting with reports • Building qualitative codebook and analyzing 80 in-depth interviews • Writing policy briefs, issue briefs on Covid-19 impact on SUD treatments • Preparing manuscripts <p>2. Conducting data analysis (STATA) for reports for Virginia Department of Medical Assistance Services on New Medicaid Expansion Members “Describe Health and Health care: Experiences from the Year Before Enrolling”.</p> <p>3. Assisting with data analysis (STATA) and first author for a manuscript examining relationships between risk preference, time preference, and substance use/ intensity of using, Youth E-cigarette Advertising (YEA) study, Virginia.</p>

05/2017 – 9/2017	Humphrey fellowship at Johns Hopkins University
Position	Humphrey scholar
Description	<ul style="list-style-type: none"> • Networked with experts on HIV/AIDS, substance abuse, health policy from Johns Hopkins University, NIDA. • Participated in seminars with experts and professors on public health, HIV/AIDS, and substance abuse and weekly meetings on study implementation. • Conducted data analysis (STATA) on HIV/AIDS and substance abuse data from JHU • Learned new and updated methods and comprehensive perspective on designing studies on HIV/AIDS and drug abuse treatment and services in Baltimore • Examined new methods and comprehensive perspective on HIV/AIDS and drug abuse treatment and service, prevention, and health policy advocacy for public health benefits.
01-04/2017	Department of Rehabilitation Counseling and Mental Health, Virginia Commonwealth University
Position	Intern
Description	Developed a manuscript focused on opioids related policy change in Vietnam and participating data analysis for gaming and other high-risk behavior study.
08/2016 – 05/2017	Fulbright-Humphrey fellowship program at Virginia Commonwealth University
Position	Humphrey fellow
Description	<p>Ten months of graduate level study, leadership development and professional collaboration with the U.S counterparts</p> <ul style="list-style-type: none"> • Epidemiology of Psychiatric and Substance Abuse Behaviors & Population Level Health Behavior Change courses • Selected for the Humphrey Program Community College Residency Program at Northern Virginia Community College giving lectures, meeting with students and faculty • Professional contacts within the U.S: National Institute on Drug Abuse International Program, the U.S. State Department Bureau of Educational Affairs, Bureau of Narcotics and Law Enforcement, the Open Society Foundation (a Soros affiliate), Johns Hopkins School of Public Health.
12/2013 – 8/2016	Center for Research and Training on HIV/AIDS (CREATA), Hanoi Medical University (2013-2016)
Position	Scientist Researcher
Description	<ul style="list-style-type: none"> • Co-Investigator of the project “Scale-Up, Sustainability and Country Ownership: The Social and Structural Determinants of the Next Phase of HIV/AIDS Policy in Vietnam” (2013-2015), funded by the US NIH, R24 HD056691-06 (PIs: Hirsch & Parker)

- Family as Recovery capital for HIV- infected injection drug users in Vietnam, funded by NIH, US (2015-2016), R03 DA037783 (PI: Le Minh Giang)
 - Vietnam Screening, Brief Intervention and Referral to Treatment in HIV OPCs and VCTs project (V-SBIRT), UCLA (2014-2016)
 - Activities, roles and challenges of civil society organizations in HIV/AIDS prevention in Vietnam, funded by Global Fund (2014-2016)
 - Project Atlantic Philanthropies_ FHI360, Study on “Development of National Drug Policy and Local Responses in Hai Phong city, Vietnam”
 - Editing Consultant for the Vietnam HIV-Addiction Technology Center, SAMSHA 1UD1-TI023603 (PI: Richard Rawson)
 - STAR project, study on “Harm Reduction for drug users after Doi Moi reform: policy change and impact”. Funded by the U.S NIH, R24 HD056691 (PI: Hirsch)
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Presentations

1. Huyen Pham, Sarah Marks, Peter Cunningham, Lauryn Walker, Andrew J. Barnes. Associations between Perceptions of Treatment for Opioid Use Disorder, Unmet Needs for Treatment, and Treatment Discontinuation Among Virginia Medicaid Members. AcademyHealth Annual Conference, June 2021.
2. Huyen Pham, Lauryn Walker, Andrew J. Barnes, Peter Cunningham. *Differences in Treatment for Substance Use Disorders by Insurance Status: Self-Help versus Outpatient Medical Treatment* (Poster presentation). AcademyHealth Annual Conference, June 2019.
3. Huyen Pham, Lauryn Walker, Andrew J. Barnes, Peter Cunningham. *Differences in Treatment for Substance Use Disorders by Insurance Status: Self-Help versus Outpatient Medical Treatment* (Oral presentation). Association for Public Policy and Management (APPAM), March 2019
4. Huyen Pham, Rose S. Bono, Giang M. Le, Andrew J. Barnes. *Economic evaluations of opioid treatments in South East Asia* (Poster presentation). Addiction Health Services Research (AHSR) Conference, Savannah, October 17-19, 2018.
5. Huyen, P.T.T., Giang, L.M. *Official Images of Drug User over past five decades: a discourse analysis* (Oral presentation). Ms. Huyen Pham has been awarded a scholarship to be presented in the International Society Study of Drug Policy (ISSDP), in Sydney Australia, in May 2016.

Guest lecture

1. “Opioid epidemic and HIV/AIDS in Vietnam”. Guest lecture at the Northern Virginia Community College, in March 2017.
2. “HIV/AIDS in Vietnam”. Guest lecture at the Reynolds Community College, Virginia, in 2016.

Publications

1. Andrew Barnes, L. Morgan Snell, Lauren Guerra, Megan Mueller, **Huyen Pham**, Erin Britton, Heather Saunders, E. Marshall Brooks, Alex Krist, Peter Cunningham. Experiences Prior to Enrollment in Medicaid: New Medicaid expansion members describe health and healthcare experiences from the year before enrolling. Report. October 2019. https://www.dmas.virginia.gov/files/links/5122/Medicaid%20Expansion%20New%20Member%20Survey%20Final%20Report_Website.pdf
2. Lauryn Saxe Walker, **Huyen Pham**, Peter Cunningham, Andrew Barnes. Substance Use Disorder Treatment in Virginia: A Role for Medicaid Expansion. https://hbp.vcu.edu/media/hbp-dev/pdfx27s/policy-briefs/arts/HBP_ARTSIssue04_ACC.pdf. February 2019
3. **Huyen, P.T.T**, Giang, L.M, Thuy, D.T.T, Claire, E. (2012). Drug users' images in Nhan dan newspaper: the shift, existing ambiguities and challenges to harm reduction in Vietnam. *Gender, Sexuality and Health Monograph*-ISSN 1859-4247, vol 25/2012.

Working papers

1. **Huyen Pham**, Peter J. Cunningham, Robert L. Balster, J. Randy Koch, Andrew J. Barnes. *Differences in Treatment for Substance Use Disorders by Insurance Status: Self-Help versus Outpatient Medical Treatment*.
2. **Huyen Pham**, Yaniv Hanoch, Rose S. Bono, Andrew J. Barnes, Caroline O. Cobb. *Go. Faster. Now: Associations of Sensation Seeking and Time Discounting with Alcohol, Cannabis, and Tobacco Use among Adolescents in Virginia*. Submitting to Psychology of Addictive Behaviors journal in June 2021
3. **Huyen Pham**, Sarah Marks, Andrew J. Barnes, Peter J. Cunningham. *Associations of unmet need, treatment discontinuation with perception treatment index, type of OUD treatment received, and member characteristics*.
4. Sarah Marks, **Huyen Pham**, Andrew J. Barnes, Peter J. Cunningham. *Associations of treatment impact with perception treatment index, type of OUD treatment received, and member characteristics*.
5. Hannah Shadowen, **Huyen Pham**, Sarah Marks, Heather Saunders, Peter J. Cunningham, Andrew J. Barnes. *Virginia Medicaid Members with Opioid Use Disorder Report Positive Experiences with Treatment, Perceptions of Treatment Quality and Impact on Their Lives* (Policy brief).

Awards/ Scholarships

1. VCU Graduate School and Department of Behavior and Health Policy scholarships for a presentation of "Economic evaluations of opioid treatments in Southeast Asia", Addiction Health Services Research (AHSR) Conference, Savannah, Oct 17-19, 2018.
2. Fulbright-Humphrey Fellowship on Substance Abuse Education, Treatment, and Prevention. 2016-2017, by the U.S Department of States.
3. Scholarship for presenting "Official Images of Drug User over past five decades: a discourse analysis" in the International Society Study of Drug Policy (ISSDP) in Sydney, Australia, in May 2016.
4. Australian Government Scholarship in 2012 for Master Program in the University of Queensland, Australia
5. Four consecutive scholarships for excellent academic performance by Hanoi Medical University, 2004-2008.

APPENDIX 4. FULL TABLES

Appendix 4-A

Full tables from chapter 3 (with details for state and year fixed effects)

Table 4-A1. 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	229,291	229,291	229,291
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Medicaid expansion			
Yes	1.18*** (1.11 - 1.24)	2.28*** (2.13 - 2.44)	1.31*** (1.24 - 1.38)
MAT (No= ref)			
Yes	0.64*** (0.62 - 0.66)	0.34*** (0.33 - 0.36)	0.14*** (0.13 - 0.14)
Frequency of use (No past month use= ref)			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.63 - 0.68)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.38)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.01 (0.97 - 1.04)	0.99 (0.97 - 1.02)
45-64	1.11*** (1.07 - 1.15)	0.81*** (0.78 - 0.85)	0.87*** (0.84 - 0.90)
Gender (Female=ref)			
Male	0.88*** (0.86 - 0.90)	0.62*** (0.61 - 0.64)	1.32*** (1.29 - 1.35)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.01 (0.96 - 1.07)	1.35*** (1.27 - 1.44)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.85 - 0.95)	1.30*** (1.23 - 1.37)	1.21*** (1.15 - 1.27)
Other	0.87*** (0.81 - 0.94)	1.03 (0.95 - 1.11)	0.96 (0.90 - 1.03)
Education (Less than high school= ref)			
Highschool or higher	0.96** (0.93 - 0.99)	0.79*** (0.76 - 0.81)	0.77*** (0.75 - 0.79)

Number of arrests (0= ref)			
1	0.85*** (0.80 - 0.91)	1.18*** (1.10 - 1.26)	2.71*** (2.58 - 2.85)
2 or more	0.86** (0.77 - 0.96)	0.96 (0.83 - 1.11)	1.09 (0.99 - 1.20)
Employment status (Not employed= ref)			
Employed	1.32*** (1.28 - 1.36)	1.15*** (1.11 - 1.19)	0.94*** (0.92 - 0.97)
Comorbidity (No= ref)			
Yes	1.48*** (1.44 - 1.52)	0.91*** (0.89 - 0.94)	0.65*** (0.63 - 0.67)
Homeless (No= ref)			
Yes	1.31*** (1.25 - 1.38)	1.37*** (1.29 - 1.45)	0.61*** (0.57 - 0.65)
Polysubstance use (no= ref)			
One more	0.99 (0.96 - 1.02)	1.03 (0.99 - 1.06)	0.85*** (0.83 - 0.88)
Two or more	0.98 (0.95 - 1.01)	1.07*** (1.03 - 1.11)	0.95** (0.92 - 0.98)
Year (2010= ref)			
2011	0.96 (0.91 - 1.01)	0.76*** (0.72 - 0.80)	1.00 (0.95 - 1.05)
2012	0.91*** (0.86 - 0.95)	0.73*** (0.69 - 0.78)	1.11*** (1.06 - 1.17)
2013	0.86*** (0.82 - 0.91)	0.68*** (0.64 - 0.72)	1.18*** (1.12 - 1.24)
2014	0.83*** (0.78 - 0.89)	0.37*** (0.34 - 0.40)	0.99 (0.93 - 1.05)
2015	0.78*** (0.71 - 0.86)	0.45*** (0.40 - 0.50)	1.12* (1.02 - 1.22)
2016	0.66*** (0.60 - 0.73)	0.47*** (0.42 - 0.52)	1.14** (1.05 - 1.25)
2017	0.63*** (0.58 - 0.69)	0.48*** (0.43 - 0.53)	0.99 (0.91 - 1.08)
State (Alabama = ref)			
Alaska	0.62 (0.35 - 1.08)	0.53* (0.31 - 0.92)	1.44 (0.84 - 2.47)
Arizona	0.48** (0.30 - 0.77)	0.12*** (0.07 - 0.19)	0.19*** (0.11 - 0.31)
Arkansas	0.40*** (0.24 - 0.68)	0.54* (0.32 - 0.89)	0.61 (0.35 - 1.04)
Colorado	0.47**	0.32***	0.74

	(0.29 - 0.77)	(0.19 - 0.51)	(0.44 - 1.22)
Connecticut	0.29***	0.09***	0.78
	(0.18 - 0.47)	(0.05 - 0.15)	(0.47 - 1.29)
Delaware	1.40	0.06***	1.12
	(0.87 - 2.25)	(0.04 - 0.10)	(0.68 - 1.85)
District of Columbia	3.26***	0.36*	0.71
	(1.79 - 5.94)	(0.17 - 0.80)	(0.34 - 1.48)
Florida	0.37***	0.56*	0.91
	(0.23 - 0.60)	(0.34 - 0.90)	(0.55 - 1.50)
Hawaii	0.36**	0.31***	1.08
	(0.18 - 0.74)	(0.16 - 0.59)	(0.60 - 1.95)
Idaho	1.71	0.99	5.64***
	(0.95 - 3.07)	(0.53 - 1.83)	(3.19 - 9.96)
Illinois	0.86	0.16***	0.73
	(0.54 - 1.38)	(0.10 - 0.26)	(0.44 - 1.21)
Indiana	0.66	0.29***	0.73
	(0.40 - 1.06)	(0.18 - 0.48)	(0.44 - 1.22)
Iowa	0.84	0.22***	0.70
	(0.51 - 1.36)	(0.13 - 0.36)	(0.42 - 1.17)
Kansas	0.79	0.37***	1.12
	(0.48 - 1.30)	(0.22 - 0.63)	(0.67 - 1.87)
Kentucky	0.68	0.55*	1.31
	(0.43 - 1.09)	(0.34 - 0.88)	(0.80 - 2.16)
Louisiana	1.00	1.30	1.25
	(0.60 - 1.68)	(0.78 - 2.15)	(0.74 - 2.12)
Maine	0.77	0.15***	0.54*
	(0.48 - 1.24)	(0.09 - 0.25)	(0.32 - 0.89)
Maryland	0.31***	0.21***	0.85
	(0.20 - 0.51)	(0.13 - 0.34)	(0.52 - 1.41)
Massachusetts	1.08	0.20***	1.75*
	(0.67 - 1.75)	(0.12 - 0.33)	(1.05 - 2.90)
Michigan	1.68*	0.41***	0.86
	(1.05 - 2.69)	(0.25 - 0.67)	(0.52 - 1.41)
Minnesota	0.97	0.25***	0.70
	(0.58 - 1.61)	(0.14 - 0.44)	(0.41 - 1.19)
Missouri	0.29***	0.28***	0.96
	(0.17 - 0.48)	(0.17 - 0.46)	(0.58 - 1.59)
Montana	0.92	0.08***	1.34
	(0.55 - 1.53)	(0.04 - 0.15)	(0.79 - 2.26)
Nebraska	0.75	0.32***	0.99
	(0.40 - 1.40)	(0.16 - 0.62)	(0.55 - 1.80)
Nevada	0.43	0.33*	0.35
	(0.14 - 1.35)	(0.11 - 0.96)	(0.09 - 1.32)
New Hampshire	1.34	0.10***	1.36
	(0.81 - 2.19)	(0.06 - 0.18)	(0.81 - 2.29)
New Jersey	0.23***	0.38***	1.14
	(0.14 - 0.36)	(0.24 - 0.62)	(0.69 - 1.89)
New Mexico	0.66	0.22*	0.50
	(0.26 - 1.69)	(0.07 - 0.71)	(0.14 - 1.71)

New York	0.73 (0.46 - 1.18)	0.38*** (0.24 - 0.61)	0.53* (0.33 - 0.88)
North Carolina	0.98 (0.61 - 1.57)	0.30*** (0.18 - 0.48)	0.65 (0.40 - 1.07)
North Dakota	1.22 (0.48 - 3.10)	0.19* (0.05 - 0.71)	1.73 (0.74 - 4.06)
Ohio	0.94 (0.59 - 1.51)	0.39*** (0.24 - 0.64)	1.55 (0.94 - 2.56)
Oklahoma	0.25*** (0.14 - 0.42)	0.62 (0.38 - 1.02)	1.11 (0.67 - 1.86)
Pennsylvania	4.58*** (2.78 - 7.53)	1.10 (0.66 - 1.86)	2.51*** (1.48 - 4.26)
Rhode Island	0.54* (0.33 - 0.88)	0.09*** (0.05 - 0.16)	0.61 (0.36 - 1.01)
South Carolina	0.67 (0.41 - 1.11)	0.82 (0.50 - 1.33)	0.62 (0.37 - 1.03)
South Dakota	0.97 (0.49 - 1.94)	0.50 (0.23 - 1.05)	1.48 (0.78 - 2.82)
Tennessee	1.27 (0.76 - 2.12)	0.37*** (0.22 - 0.65)	3.14*** (1.87 - 5.28)
Utah	0.88 (0.54 - 1.42)	0.57* (0.35 - 0.93)	2.37*** (1.43 - 3.91)
Washington	0.85 (0.53 - 1.37)	0.97 (0.60 - 1.57)	1.06 (0.64 - 1.75)
Wyoming	0.94 (0.46 - 1.92)	0.38* (0.17 - 0.88)	0.73 (0.37 - 1.46)

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-A2. DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	AOR	AOR	AOR
	(95% CI)	(95% CI)	(95% CI)
Expansion	0.84 (0.52 - 1.35)	0.94 (0.58 - 1.52)	1.06 (0.64 - 1.75)
Post expansion	0.70*** (0.66 - 0.75)	0.42*** (0.39 - 0.45)	0.82*** (0.78 - 0.87)
Expansion * Post expansion	1.18*** (1.12 - 1.25)	2.39*** (2.23 - 2.56)	1.32*** (1.25 - 1.39)
MAT (No= ref)			
Yes	0.65*** (0.63 - 0.67)	0.34*** (0.32 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.64 - 0.69)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.38*** (0.36 - 0.39)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.00 (0.97 - 1.03)	0.99 (0.97 - 1.02)
45-64	1.11*** (1.07 - 1.15)	0.81*** (0.77 - 0.85)	0.87*** (0.84 - 0.90)
Gender			
Male	0.88*** (0.86 - 0.90)	0.62*** (0.60 - 0.64)	1.32*** (1.29 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02 (0.96 - 1.07)	1.36*** (1.28 - 1.45)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.85 - 0.94)	1.31*** (1.24 - 1.39)	1.21*** (1.15 - 1.27)
Other	0.88*** (0.82 - 0.95)	1.04 (0.96 - 1.12)	0.98 (0.92 - 1.06)
Education			
Highschool or higher	0.96* (0.94 - 0.99)	0.81*** (0.78 - 0.84)	0.78*** (0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83*** (0.78 - 0.89)	1.20*** (1.12 - 1.28)	2.73*** (2.60 - 2.87)
2 or more	0.86* (0.77 - 0.97)	0.96 (0.83 - 1.12)	1.08 (0.98 - 1.20)
Employment status			
Employed	1.33***	1.14***	0.93***

	(1.29 - 1.37)	(1.10 - 1.18)	(0.91 - 0.96)
Comorbidity			
Yes	1.50*** (1.46 - 1.54)	0.91*** (0.88 - 0.94)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.26 - 1.40)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	1.00 (0.97 - 1.03)	1.02 (0.98 - 1.05)	0.85*** (0.82 - 0.87)
Two or more	0.99 (0.95 - 1.02)	1.06** (1.02 - 1.10)	0.94*** (0.91 - 0.97)
Year			
2011	0.96 (0.91 - 1.01)	0.75*** (0.71 - 0.80)	1.00 (0.95 - 1.05)
2012	0.89*** (0.85 - 0.94)	0.72*** (0.68 - 0.76)	1.11*** (1.06 - 1.17)
2013	0.85*** (0.81 - 0.90)	0.66*** (0.63 - 0.70)	1.18*** (1.12 - 1.24)
2014	1.32*** (1.21 - 1.44)	0.75*** (0.69 - 0.83)	0.98 (0.91 - 1.06)
2015	1.22*** (1.17 - 1.29)	0.92** (0.87 - 0.97)	1.13*** (1.07 - 1.18)
2016	1.04 (0.99 - 1.09)	0.98 (0.93 - 1.03)	1.16*** (1.11 - 1.21)
State			
Arizona	0.60*** (0.54 - 0.66)	0.13*** (0.12 - 0.14)	0.19*** (0.17 - 0.21)
Arkansas	0.48*** (0.37 - 0.62)	0.55*** (0.45 - 0.66)	0.58*** (0.46 - 0.72)
Colorado	0.55*** (0.48 - 0.63)	0.33*** (0.29 - 0.38)	0.71*** (0.63 - 0.81)
Connecticut	0.34*** (0.29 - 0.40)	0.10*** (0.08 - 0.12)	0.74*** (0.65 - 0.84)
Delaware	1.66*** (1.48 - 1.87)	0.06*** (0.05 - 0.08)	1.07 (0.95 - 1.20)
District of Columbia	3.98*** (2.71 - 5.83)	0.42** (0.22 - 0.80)	0.76 (0.44 - 1.32)
Florida	0.38*** (0.23 - 0.61)	0.55* (0.34 - 0.90)	0.92 (0.56 - 1.52)
Hawaii	0.44** (0.25 - 0.75)	0.34*** (0.22 - 0.52)	1.02 (0.74 - 1.41)
Idaho	1.8 (1.00 - 3.25)	1.03 (0.56 - 1.91)	5.85*** (3.31 - 10.34)
Illinois	1.03 (0.92 - 1.14)	0.18*** (0.16 - 0.20)	0.73*** (0.65 - 0.81)
Iowa	1.01 (0.86 - 1.17)	0.22*** (0.18 - 0.27)	0.67*** (0.57 - 0.78)
Kansas	0.81	0.37***	1.14

	(0.49 - 1.33)	(0.22 - 0.63)	(0.68 - 1.90)
Kentucky	0.82***	0.55***	1.24***
	(0.75 - 0.89)	(0.51 - 0.60)	(1.14 - 1.35)
Maine	0.78	0.15***	0.54*
	(0.49 - 1.26)	(0.09 - 0.25)	(0.32 - 0.89)
Maryland	0.38***	0.22***	0.83***
	(0.34 - 0.42)	(0.20 - 0.25)	(0.75 - 0.92)
Massachusetts	1.30***	0.21***	1.68***
	(1.13 - 1.48)	(0.17 - 0.25)	(1.48 - 1.91)
Michigan	2.03***	0.42***	0.81***
	(1.84 - 2.23)	(0.38 - 0.47)	(0.73 - 0.90)
Mississippi	1	0.26***	0.72
	(0.60 - 1.66)	(0.15 - 0.45)	(0.42 - 1.21)
Missouri	0.30***	0.29***	0.98
	(0.18 - 0.50)	(0.17 - 0.48)	(0.59 - 1.63)
Nebraska	0.75	0.33**	1.02
	(0.40 - 1.41)	(0.17 - 0.65)	(0.56 - 1.84)
Nevada	0.56	0.36*	0.36
	(0.19 - 1.61)	(0.14 - 0.98)	(0.10 - 1.27)
New Hampshire	1.60***	0.10***	1.28**
	(1.34 - 1.92)	(0.07 - 0.14)	(1.08 - 1.51)
New Jersey	0.27***	0.41***	1.11
	(0.23 - 0.30)	(0.37 - 0.45)	(0.99 - 1.23)
New Mexico	0.6	0.15*	0.61
	(0.23 - 1.56)	(0.03 - 0.65)	(0.18 - 2.00)
New York	0.88**	0.40***	0.52***
	(0.80 - 0.95)	(0.37 - 0.44)	(0.48 - 0.56)
North Carolina	1.01	0.29***	0.66
	(0.63 - 1.61)	(0.18 - 0.47)	(0.40 - 1.07)
North Dakota	1.43	0.19**	1.61
	(0.64 - 3.21)	(0.05 - 0.66)	(0.80 - 3.24)
Ohio	1.13*	0.40***	1.46***
	(1.02 - 1.25)	(0.36 - 0.44)	(1.33 - 1.61)
Oklahoma	0.25***	0.65	1.14
	(0.15 - 0.43)	(0.40 - 1.07)	(0.68 - 1.89)
Rhode Island	0.66***	0.09***	0.53***
	(0.57 - 0.76)	(0.07 - 0.12)	(0.45 - 0.62)
South Carolina	0.69	0.81	0.62
	(0.42 - 1.14)	(0.50 - 1.32)	(0.37 - 1.04)
South Dakota	1	0.51	1.49
	(0.50 - 1.98)	(0.24 - 1.07)	(0.79 - 2.83)
Tennessee	1.3	0.38***	3.24***
	(0.78 - 2.16)	(0.22 - 0.67)	(1.93 - 5.43)
Utah	0.89	0.59*	2.43***
	(0.55 - 1.44)	(0.36 - 0.96)	(1.47 - 4.01)
Wyoming	0.98	0.39*	0.73
	(0.48 - 1.99)	(0.17 - 0.90)	(0.37 - 1.47)

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-A3. 2WFE model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	168,165	168,165	168,165
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expanded	1.17*** (1.10 - 1.24)	2.36*** (2.19 - 2.54)	1.25*** (1.18 - 1.32)
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.64 - 0.70)	0.67*** (0.64 - 0.70)	0.40*** (0.38 - 0.41)
Daily use	0.59*** (0.57 - 0.61)	0.41*** (0.39 - 0.43)	0.18*** (0.17 - 0.19)
Age (18-29= ref)			
30-44	1.03 (0.99 - 1.06)	1.00 (0.96 - 1.03)	0.98 (0.96 - 1.01)
45-64	1.21*** (1.16 - 1.27)	0.82*** (0.78 - 0.86)	0.91*** (0.88 - 0.95)
Gender (Female=ref)			
Male	0.91*** (0.88 - 0.93)	0.60*** (0.58 - 0.62)	1.33*** (1.29 - 1.36)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.14*** (1.07 - 1.22)	1.56*** (1.45 - 1.67)	1.30*** (1.23 - 1.37)
Hispanic	1.02 (0.95 - 1.09)	1.55*** (1.45 - 1.66)	1.33*** (1.26 - 1.41)
Other	0.90* (0.82 - 0.98)	1.05 (0.96 - 1.14)	0.97 (0.90 - 1.04)
Education (Less than high school= ref)			
Highschool or higher	0.94*** (0.91 - 0.97)	0.76*** (0.74 - 0.79)	0.75*** (0.73 - 0.77)
Number of arrests (0= ref)			
1	0.79*** (0.73 - 0.85)	1.13** (1.05 - 1.22)	2.48*** (2.36 - 2.62)

2 or more	0.69*** (0.61 - 0.78)	0.93 (0.79 - 1.09)	0.93 (0.84 - 1.04)
Employment status (Not employed= ref)			
Employed	1.30*** (1.25 - 1.35)	1.12*** (1.08 - 1.16)	0.92*** (0.90 - 0.95)
Comorbidity (No= ref)			
Yes	1.57*** (1.52 - 1.62)	0.85*** (0.82 - 0.88)	0.62*** (0.60 - 0.64)
Homeless (No= ref)			
Yes	1.31*** (1.23 - 1.39)	1.25*** (1.16 - 1.33)	0.57*** (0.53 - 0.61)
Polysubstance use (no= ref)			
One more	0.99 (0.95 - 1.02)	0.92*** (0.89 - 0.96)	0.78*** (0.76 - 0.81)
Two or more	0.91*** (0.88 - 0.95)	0.93*** (0.89 - 0.97)	0.84*** (0.82 - 0.87)
Year (2010= ref)			
2011	0.93* (0.87 - 0.98)	0.77*** (0.72 - 0.81)	0.98 (0.93 - 1.04)
2012	0.88*** (0.83 - 0.93)	0.73*** (0.68 - 0.77)	1.07* (1.01 - 1.12)
2013	0.83*** (0.78 - 0.88)	0.70*** (0.66 - 0.75)	1.19*** (1.13 - 1.25)
2014	0.80*** (0.75 - 0.86)	0.37*** (0.34 - 0.41)	1.03 (0.97 - 1.10)
2015	0.78*** (0.73 - 0.84)	0.38*** (0.35 - 0.41)	0.92* (0.86 - 0.99)
2016	0.67*** (0.62 - 0.71)	0.37*** (0.34 - 0.40)	0.91** (0.86 - 0.97)
2017	0.69*** (0.65 - 0.74)	0.36*** (0.34 - 0.39)	0.75*** (0.71 - 0.80)
Alaska	0.66 (0.28 - 1.55)	0.47* (0.23 - 0.95)	1.5 (0.76 - 2.94)
Arizona	0.49 (0.22 - 1.08)	0.08*** (0.04 - 0.15)	0.16*** (0.09 - 0.31)
Arkansas	0.37* (0.15 - 0.87)	0.43* (0.21 - 0.85)	0.57 (0.29 - 1.13)
Colorado	0.49 (0.22 - 1.08)	0.26*** (0.14 - 0.51)	0.71 (0.38 - 1.35)
Connecticut	0.41* (0.22 - 1.08)	0.13*** (0.14 - 0.51)	1.21 (0.38 - 1.35)

	(0.18 - 0.92)	(0.06 - 0.25)	(0.64 - 2.30)
Delaware	1.77	0.04***	1.23
	(0.80 - 3.91)	(0.02 - 0.08)	(0.65 - 2.33)
District of Columbia	1.93	0.20***	0.48
	(0.79 - 4.76)	(0.08 - 0.49)	(0.21 - 1.11)
Florida	0.75	0.71	1.25
	(0.34 - 1.66)	(0.36 - 1.37)	(0.66 - 2.36)
Hawaii	0.37*	0.24***	1.08
	(0.14 - 0.99)	(0.11 - 0.53)	(0.53 - 2.20)
Idaho	1.69	0.77	5.27***
	(0.71 - 4.03)	(0.36 - 1.66)	(2.63 - 10.56)
Illinois	0.7	0.13***	0.74
	(0.31 - 1.54)	(0.07 - 0.26)	(0.39 - 1.40)
Indiana	0.71	0.22***	0.73
	(0.32 - 1.58)	(0.11 - 0.43)	(0.38 - 1.38)
Iowa	0.69	0.16***	0.63
	(0.31 - 1.55)	(0.08 - 0.31)	(0.33 - 1.20)
Kansas	0.78	0.28***	1.04
	(0.35 - 1.74)	(0.14 - 0.55)	(0.55 - 1.99)
Kentucky	0.62	0.36**	1.1
	(0.28 - 1.36)	(0.19 - 0.69)	(0.58 - 2.07)
	0.99	0.76	1.04
	(0.44 - 2.25)	(0.39 - 1.50)	(0.54 - 2.02)
Maine	0.92	0.16***	0.64
	(0.41 - 2.05)	(0.08 - 0.32)	(0.33 - 1.21)
Maryland	0.46	0.21***	1.03
	(0.21 - 1.02)	(0.11 - 0.41)	(0.54 - 1.94)
Massachusetts	0.87	0.16***	1.66
	(0.39 - 1.93)	(0.08 - 0.31)	(0.87 - 3.16)
Michigan	1.48	0.27***	0.78
	(0.67 - 3.25)	(0.14 - 0.52)	(0.41 - 1.47)
Mississippi	1.01	0.20***	0.65
	(0.45 - 2.27)	(0.10 - 0.41)	(0.34 - 1.26)
Missouri	0.25**	0.21***	0.9
	(0.11 - 0.58)	(0.11 - 0.42)	(0.47 - 1.71)
Montana	0.92	0.06***	1.25
	(0.41 - 2.07)	(0.03 - 0.13)	(0.65 - 2.41)
Nebraska	0.79	0.24***	0.83
	(0.32 - 1.94)	(0.11 - 0.55)	(0.41 - 1.71)
Nevada	0.64	0.19	0.55
	(0.11 - 3.61)	(0.04 - 1.03)	(0.12 - 2.41)
New Hampshire	1.29	0.07***	1.28

	(0.58 - 2.89)	(0.03 - 0.14)	(0.67 - 2.44)
New Jersey	0.48	0.54	2.02*
	(0.21 - 1.07)	(0.28 - 1.06)	(1.06 - 3.83)
New Mexico	0	0.51	0.83
	(0.00 - .)	(0.09 - 3.01)	(0.14 - 5.03)
New York	0.79	0.28***	0.47*
	(0.36 - 1.74)	(0.15 - 0.55)	(0.25 - 0.88)
North Carolina	0.93	0.19***	0.57
	(0.43 - 2.05)	(0.10 - 0.37)	(0.30 - 1.08)
North Dakota	1.22	0.14**	1.65
	(0.39 - 3.75)	(0.03 - 0.56)	(0.65 - 4.20)
Ohio	0.64	0.27***	1.26
	(0.29 - 1.40)	(0.14 - 0.52)	(0.67 - 2.38)
Oklahoma	0.26**	0.49*	1.09
	(0.11 - 0.58)	(0.25 - 0.96)	(0.57 - 2.08)
Pennsylvania	5.45***	0.45*	2.33*
	(2.41 - 12.31)	(0.22 - 0.92)	(1.20 - 4.55)
Rhode Island	1.06	0.12***	0.86
	(0.47 - 2.38)	(0.06 - 0.25)	(0.44 - 1.65)
South Carolina	0.65	0.53	0.53
	(0.29 - 1.44)	(0.27 - 1.03)	(0.28 - 1.01)
South Dakota	0.87	0.33*	1.16
	(0.33 - 2.24)	(0.14 - 0.81)	(0.55 - 2.47)
Tennessee	1.25	0.27***	2.86**
	(0.56 - 2.82)	(0.13 - 0.55)	(1.50 - 5.48)
Utah	0.86	0.37**	2.22*
	(0.39 - 1.91)	(0.19 - 0.72)	(1.17 - 4.21)
Washington	0.92	0.74	1.14
	(0.41 - 2.04)	(0.38 - 1.43)	(0.60 - 2.16)
Wyoming	1	0.30*	0.65
	(0.39 - 2.59)	(0.12 - 0.77)	(0.29 - 1.44)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR.

Confidence Interval = CI.

Table 4-A4. 2WFE model for the associations among MAT, non-intensive outpatient treatment for OUD: logit models

	Healthcare provider referral	Court/criminal justice referral
N	53,295	48,302
	AOR (95%CI)	AOR (95%CI)
Medicaid expansion		
Expanded	1.10 (0.97 - 1.25)	1.31 (1.00 - 1.71)
Frequency of use (No past month use= ref)		
Some use	0.58*** (0.53 - 0.63)	0.36*** (0.32 - 0.40)
Daily use	0.38*** (0.36 - 0.41)	0.15*** (0.13 - 0.16)
Age (18-29= ref)		
30-44	0.91** (0.86 - 0.96)	0.99 (0.91 - 1.08)
45-64	0.86*** (0.80 - 0.93)	0.58*** (0.51 - 0.66)
Gender (Female=ref)		
Male	0.81*** (0.77 - 0.85)	1.14*** (1.06 - 1.24)
Race/ethnicity (non-Hispanic White=ref)		
Non-Hispanic Black	0.87** (0.79 - 0.95)	0.99 (0.85 - 1.17)
Hispanic	0.81*** (0.73 - 0.89)	0.81** (0.69 - 0.93)
Other	0.83* (0.71 - 0.97)	0.91 (0.71 - 1.15)
Education (Less than high school= ref)		
Highschool or higher	0.97 (0.92 - 1.02)	0.87*** (0.80 - 0.94)
Number of arrests (0= ref)		

1	0.98 (0.86 - 1.13)	5.34*** (4.69 - 6.08)
2 or more	1.45** (1.11 - 1.90)	2.01*** (1.38 - 2.93)
Employment status (Not employed= ref)		
Employed	1.37*** (1.29 - 1.46)	0.98 (0.90 - 1.07)
Comorbidity (No= ref)		
Yes	1.20*** (1.14 - 1.27)	1.01 (0.93 - 1.10)
Homeless (No= ref)		
Yes	1.31*** (1.18 - 1.44)	0.82* (0.68 - 0.98)
Polysubstance use (no= ref)		
One more	0.93** (0.88 - 0.98)	1.57*** (1.43 - 1.72)
Two or more	1.09* (1.02 - 1.16)	2.23*** (2.02 - 2.46)
Year (2010= ref)		
2011	0.98 (0.87 - 1.09)	0.64*** (0.55 - 0.75)
2012	0.91 (0.81 - 1.03)	0.74*** (0.63 - 0.86)
2013	0.89* (0.79 - 1.00)	0.57*** (0.48 - 0.67)
2014	0.91 (0.78 - 1.06)	0.31*** (0.25 - 0.39)
2015	1.12 (0.93 - 1.36)	0.45*** (0.35 - 0.58)
2016	0.95 (0.78 - 1.14)	0.59*** (0.46 - 0.75)
2017	0.72*** (0.60 - 0.86)	0.51*** (0.40 - 0.65)
State		
Alaska	0.54 (0.22 - 1.29)	0.40 (0.10 - 1.62)
Arizona	0.34*** (0.18 - 0.63)	0.26** (0.10 - 0.67)
Arkansas	0.44* (0.22 - 0.87)	0.49 (0.17 - 1.39)
Colorado	0.47* (0.22 - 0.87)	0.63 (0.17 - 1.39)

	(0.25 - 0.87)	(0.24 - 1.64)
Connecticut	0.23***	0.06***
	(0.12 - 0.43)	(0.02 - 0.17)
Delaware	1.04	0.45
	(0.56 - 1.92)	(0.17 - 1.18)
District of Columbia	10.76***	1.43
	(4.00 - 28.90)	(0.14 - 14.32)
Florida	0.15***	0.33*
	(0.08 - 0.29)	(0.13 - 0.84)
Hawaii	0.39	0.50
	(0.10 - 1.47)	(0.05 - 4.60)
Idaho	2.19	3.53
	(0.60 - 7.94)	(0.71 - 17.56)
Illinois	1.10	0.27**
	(0.60 - 2.02)	(0.11 - 0.71)
Indiana	0.31**	0.15**
	(0.15 - 0.64)	(0.04 - 0.48)
Iowa	2.58**	0.47
	(1.31 - 5.08)	(0.13 - 1.66)
Kentucky	0.91	1.78
	(0.50 - 1.67)	(0.70 - 4.50)
Nebraska	-	
Maine	0.70	0.26**
	(0.39 - 1.29)	(0.10 - 0.66)
Maryland	0.23***	0.30*
	(0.12 - 0.42)	(0.12 - 0.77)
Massachusetts	1.48	0.55
	(0.80 - 2.77)	(0.20 - 1.49)
Michigan	1.95*	0.37*
	(1.06 - 3.56)	(0.14 - 0.96)
Mississippi	0.73	1.51
	(0.20 - 2.60)	(0.31 - 7.39)
Missouri	0.39**	0.60
	(0.20 - 0.77)	(0.22 - 1.62)
Nebraska	0.55	3.75
	(0.11 - 2.77)	(0.91 - 15.51)
Nevada	0.28	
	(0.06 - 1.39)	
New Hampshire	2.16	1.63
	(0.95 - 4.89)	(0.50 - 5.34)
New Jersey	0.20***	0.42
	(0.11 - 0.38)	(0.16 - 1.06)
New Mexico	0.81	0.38

	(0.29 - 2.24)	(0.04 - 3.54)
New York	0.61	0.74
	(0.33 - 1.11)	(0.29 - 1.87)
North Carolina	1.07	0.16***
	(0.59 - 1.94)	(0.06 - 0.40)
Ohio	1.78	1.79
	(0.97 - 3.26)	(0.70 - 4.56)
Pennsylvania	3.31***	1.52
	(1.69 - 6.46)	(0.53 - 4.35)
Rhode Island	0.39**	0.21**
	(0.21 - 0.72)	(0.08 - 0.57)
South Carolina	0.85	0.51
	(0.37 - 1.97)	(0.16 - 1.63)
South Dakota	2.57	8.40*
	(0.50 - 13.23)	(1.51 - 46.86)
Tennessee	-	
Utah	0.93	0.66
	(0.50 - 1.74)	(0.25 - 1.74)
Washington	0.73	0.39*
	(0.39 - 1.34)	(0.15 - 1.00)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A5. DID model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	164,420	164,420	164,420
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion	0.91 (0.41 - 2.01)	0.71 (0.37 - 1.38)	1.14 (0.60 - 2.16)
Post expansion	0.68*** (0.64 - 0.73)	0.34*** (0.32 - 0.37)	0.75*** (0.70 - 0.80)
Expansion * Post expansion	1.18*** (1.10 - 1.25)	2.50*** (2.31 - 2.69)	1.25*** (1.18 - 1.32)
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.64 - 0.70)	0.67*** (0.65 - 0.70)	0.40*** (0.38 - 0.41)
Daily use	0.59*** (0.57 - 0.61)	0.41*** (0.40 - 0.43)	0.18*** (0.17 - 0.19)
Age (18-29= ref)			
30-44	1.02 (0.99 - 1.06)	1.00 (0.96 - 1.03)	0.98 (0.96 - 1.01)
45-64	1.21*** (1.16 - 1.27)	0.82*** (0.78 - 0.86)	0.91*** (0.87 - 0.95)
Gender (Female=ref)			
Male	0.91*** (0.88 - 0.94)	0.59*** (0.57 - 0.61)	1.32*** (1.29 - 1.36)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.16*** (1.08 - 1.23)	1.56*** (1.45 - 1.68)	1.30*** (1.22 - 1.37)
Hispanic	1.02 (0.95 - 1.10)	1.56*** (1.46 - 1.68)	1.34*** (1.26 - 1.42)
Other	0.90* (0.83 - 0.99)	1.06 (0.97 - 1.16)	0.99 (0.92 - 1.07)
Education (Less than high school= ref)			
Highschool or higher	0.94** (0.91 - 0.98)	0.77*** (0.74 - 0.80)	0.75*** (0.73 - 0.78)
Number of arrests (0= ref)			

1	0.77*** (0.71 - 0.84)	1.13** (1.05 - 1.22)	2.48*** (2.36 - 2.62)
2 or more	0.71*** (0.62 - 0.80)	0.92 (0.78 - 1.08)	0.92 (0.83 - 1.03)
Employment status (Not employed= ref)			
Employed	1.31*** (1.27 - 1.36)	1.12*** (1.08 - 1.16)	0.92*** (0.90 - 0.95)
Comorbidity (No= ref)			
Yes	1.59*** (1.54 - 1.64)	0.85*** (0.82 - 0.88)	0.62*** (0.60 - 0.64)
Homeless (No= ref)			
Yes	1.34*** (1.26 - 1.42)	1.24*** (1.15 - 1.32)	0.56*** (0.52 - 0.60)
Polysubstance use (no= ref)			
One more	1.00 (0.96 - 1.03)	0.92*** (0.88 - 0.95)	0.78*** (0.75 - 0.80)
Two or more	0.92*** (0.89 - 0.96)	0.93*** (0.89 - 0.96)	0.83*** (0.80 - 0.86)
Year (2010= ref)			
2011	0.92** (0.87 - 0.98)	0.76*** (0.71 - 0.81)	0.98 (0.93 - 1.03)
2012	0.86*** (0.81 - 0.91)	0.71*** (0.67 - 0.76)	1.06* (1.00 - 1.12)
2013	0.83*** (0.78 - 0.88)	0.68*** (0.64 - 0.73)	1.18*** (1.12 - 1.24)
2014	1.16*** (1.10 - 1.23)	1.00 (0.94 - 1.07)	1.36*** (1.30 - 1.43)
2015	1.13*** (1.06 - 1.20)	1.02 (0.95 - 1.09)	1.22*** (1.16 - 1.28)
2016	0.96 (0.90 - 1.01)	1.02 (0.95 - 1.08)	1.21*** (1.15 - 1.27)
State			
Arizona	0.54*** (0.47 - 0.62)	0.10*** (0.09 - 0.12)	0.14*** (0.13 - 0.16)
Arkansas	0.40*** (0.28 - 0.58)	0.57*** (0.45 - 0.73)	0.50*** (0.39 - 0.65)
Colorado	0.53*** (0.44 - 0.65)	0.35*** (0.30 - 0.41)	0.62*** (0.54 - 0.72)
Connecticut	0.45*** (0.36 - 0.56)	0.17*** (0.13 - 0.21)	1.06 (0.91 - 1.24)

Delaware	1.93*** (1.64 - 2.27)	0.05*** (0.04 - 0.07)	1.08 (0.94 - 1.24)
District of Columbia	2.11** (1.34 - 3.32)	0.26*** (0.13 - 0.50)	0.42** (0.24 - 0.74)
Florida	0.74 (0.33 - 1.65)	0.68 (0.35 - 1.32)	1.24 (0.66 - 2.35)
Hawaii	0.40** (0.22 - 0.74)	0.32*** (0.20 - 0.51)	0.94 (0.67 - 1.32)
Idaho	1.68 (0.70 - 4.02)	0.76 (0.35 - 1.64)	5.26*** (2.63 - 10.53)
Illinois	0.76*** (0.65 - 0.88)	0.18*** (0.15 - 0.21)	0.65*** (0.57 - 0.74)
Iowa	0.76** (0.63 - 0.91)	0.21*** (0.17 - 0.26)	0.55*** (0.47 - 0.65)
Kansas	0.77 (0.34 - 1.73)	0.27*** (0.13 - 0.53)	1.04 (0.54 - 1.99)
Kentucky	0.68*** (0.60 - 0.77)	0.48*** (0.44 - 0.53)	0.96 (0.87 - 1.06)
Maine	0.92 (0.41 - 2.05)	0.16*** (0.08 - 0.31)	0.63 (0.33 - 1.21)
Maryland	0.50*** (0.43 - 0.59)	0.28*** (0.24 - 0.33)	0.9 (0.80 - 1.02)
Massachusetts	0.95 (0.79 - 1.14)	0.21*** (0.17 - 0.26)	1.46*** (1.26 - 1.68)
Michigan	1.62*** (1.42 - 1.86)	0.36*** (0.32 - 0.41)	0.68*** (0.60 - 0.76)
Mississippi	1.01 (0.45 - 2.28)	0.20*** (0.10 - 0.41)	0.65 (0.34 - 1.26)
Missouri	0.25** (0.11 - 0.58)	0.21*** (0.11 - 0.41)	0.9 (0.47 - 1.70)
Nebraska	0.79 (0.32 - 1.94)	0.24*** (0.10 - 0.54)	0.83 (0.41 - 1.71)
Nevada	0.7 (0.15 - 3.28)	0.26 (0.05 - 1.20)	0.48 (0.12 - 1.85)
New Hampshire	1.42*** (1.15 - 1.74)	0.09*** (0.06 - 0.13)	1.12 (0.94 - 1.33)
New Jersey	0.52*** (0.42 - 0.65)	0.73*** (0.62 - 0.85)	1.77*** (1.53 - 2.03)
New Mexico	0 (0.00 - .)	0.68 (0.13 - 3.53)	0.72 (0.13 - 3.92)
New York	0.86* (0.76 - 0.98)	0.38*** (0.34 - 0.42)	0.41*** (0.37 - 0.45)

North Carolina	0.93 (0.42 - 2.05)	0.19*** (0.10 - 0.36)	0.57 (0.30 - 1.07)
North Dakota	1.33 (0.59 - 2.99)	0.18** (0.05 - 0.63)	1.43 (0.71 - 2.87)
Ohio	0.70*** (0.60 - 0.80)	0.36*** (0.32 - 0.41)	1.1 (0.99 - 1.23)
Oklahoma	0.25** (0.11 - 0.58)	0.48* (0.25 - 0.95)	1.09 (0.57 - 2.08)
Rhode Island	1.16 (0.93 - 1.46)	0.16*** (0.12 - 0.23)	0.75** (0.61 - 0.91)
South Carolina	0.65 (0.29 - 1.45)	0.51* (0.26 - 1.00)	0.53 (0.28 - 1.01)
South Dakota	0.86 (0.33 - 2.24)	0.33* (0.13 - 0.79)	1.15 (0.54 - 2.45)
Tennessee	1.25 (0.56 - 2.82)	0.27*** (0.13 - 0.54)	2.86** (1.49 - 5.48)
Utah	0.86 (0.39 - 1.90)	0.36** (0.18 - 0.70)	2.22* (1.17 - 4.20)
Wyoming	1.01 (0.39 - 2.61)	0.30* (0.12 - 0.77)	0.65 (0.29 - 1.44)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A6. DID model for the associations among MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	60,852	60,852	60,852
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Expansion	0.79	1.17	0.47
	(0.43 - 1.44)	(0.54 - 2.54)	(0.18 - 1.18)
Post expansion	0.71***	0.51***	1.18
	(0.62 - 0.82)	(0.42 - 0.62)	(0.89 - 1.57)
Expansion * Post expansion	1.12	2.22***	1.33*
	(0.99 - 1.28)	(1.83 - 2.69)	(1.02 - 1.74)
Frequency of use (No past month use= ref)			
Some use	0.58***	0.69***	0.35***
	(0.53 - 0.63)	(0.62 - 0.76)	(0.32 - 0.39)
Daily use	0.38***	0.40***	0.15***
	(0.35 - 0.41)	(0.37 - 0.44)	(0.13 - 0.16)
Age (18-29= ref)			
30-44	0.92**	0.95	1.02
	(0.87 - 0.98)	(0.88 - 1.02)	(0.94 - 1.11)
45-64	0.91*	0.69***	0.61***
	(0.84 - 0.98)	(0.62 - 0.77)	(0.54 - 0.69)
Gender (Female=ref)			
Male	0.82***	0.73***	1.21***
	(0.78 - 0.86)	(0.68 - 0.78)	(1.12 - 1.30)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.88**	1.04	0.97
	(0.80 - 0.96)	(0.91 - 1.19)	(0.82 - 1.13)
Hispanic	0.82***	0.93	0.80**
	(0.74 - 0.90)	(0.82 - 1.05)	(0.69 - 0.92)
Other	0.85*	1.03	0.93
	(0.73 - 0.99)	(0.85 - 1.24)	(0.73 - 1.17)
Education (Less than high school= ref)			
Highschool or higher	0.98	0.91*	0.90*
	(0.93 - 1.03)	(0.85 - 0.98)	(0.83 - 0.98)
Number of arrests (0= ref)			

1	0.99 (0.86 - 1.14)	1.29** (1.09 - 1.52)	5.07*** (4.47 - 5.75)
2 or more	1.44** (1.10 - 1.89)	0.84 (0.53 - 1.32)	2.35*** (1.64 - 3.38)
Employment status (Not employed= ref)			
Employed	1.40*** (1.32 - 1.49)	1.21*** (1.12 - 1.31)	1.00 (0.92 - 1.09)
Comorbidity (No= ref)			
Yes	1.21*** (1.14 - 1.28)	1.26*** (1.18 - 1.35)	1.07 (0.99 - 1.16)
Homeless (No= ref)			
Yes	1.34*** (1.21 - 1.48)	1.62*** (1.44 - 1.82)	0.92 (0.77 - 1.10)
Polysubstance use (no= ref)			
One more	0.93** (0.88 - 0.98)	1.36*** (1.26 - 1.47)	1.59*** (1.46 - 1.74)
Two or more	1.07* (1.00 - 1.14)	1.47*** (1.34 - 1.60)	2.15*** (1.95 - 2.37)
Year (2010= ref)			
2011	1.00 (0.90 - 1.12)	0.64*** (0.55 - 0.75)	1.04 (0.86 - 1.26)
2012	0.90 (0.81 - 1.01)	0.68*** (0.58 - 0.79)	1.61*** (1.35 - 1.93)
2013	0.89* (0.79 - 1.00)	0.56*** (0.47 - 0.66)	1.08 (0.89 - 1.32)
2014	1.26** (1.09 - 1.45)	0.57*** (0.47 - 0.69)	0.59*** (0.48 - 0.73)
2015	1.59*** (1.45 - 1.73)	0.89* (0.79 - 0.99)	0.78*** (0.68 - 0.89)
2016	1.32*** (1.21 - 1.44)	1.13* (1.02 - 1.25)	0.95 (0.85 - 1.06)
Arizona	0.44*** (0.36 - 0.54)	0.23*** (0.18 - 0.29)	0.66* (0.48 - 0.92)
Arkansas	0.56** (0.40 - 0.80)	0.44*** (0.31 - 0.63)	1.22 (0.72 - 2.05)
Colorado	0.63*** (0.51 - 0.77)	0.22*** (0.17 - 0.29)	1.52** (1.12 - 2.08)
Connecticut	0.30*** (0.24 - 0.37)	0.02*** (0.01 - 0.04)	0.15*** (0.09 - 0.25)
Delaware	1.39***	0.10***	1.14

	(1.17 - 1.66)	(0.06 - 0.14)	(0.83 - 1.57)
District of Columbia	14.14***	0.59	2.49
	(6.39 - 31.31)	(0.07 - 4.76)	(0.28 - 22.42)
Florida	0.16***	0.22***	0.36*
	(0.09 - 0.30)	(0.10 - 0.49)	(0.14 - 0.91)
Hawaii	0.51	0.29	1.03
	(0.15 - 1.68)	(0.07 - 1.25)	(0.13 - 8.00)
Idaho	2.19	0.69	4.37
	(0.61 - 7.92)	(0.07 - 6.41)	(0.93 - 20.51)
Illinois	1.44***	0.12***	0.72
	(1.24 - 1.68)	(0.09 - 0.16)	(0.52 - 1.00)
Iowa	3.31***	0.11***	1.34
	(2.35 - 4.64)	(0.04 - 0.30)	(0.56 - 3.19)
Kentucky	1.22**	0.98	4.61***
	(1.06 - 1.40)	(0.86 - 1.13)	(3.68 - 5.76)
Maine	0.74	0.13***	0.27**
	(0.41 - 1.34)	(0.06 - 0.29)	(0.11 - 0.68)
Maryland	0.30***	0.14***	0.74*
	(0.26 - 0.36)	(0.11 - 0.17)	(0.55 - 0.98)
Massachusetts	1.96***	0.09***	1.47
	(1.60 - 2.40)	(0.05 - 0.16)	(0.96 - 2.24)
Michigan	2.58***	0.50***	1.08
	(2.25 - 2.97)	(0.42 - 0.59)	(0.80 - 1.45)
Mississippi	0.84	0.39	1.69
	(0.24 - 2.98)	(0.05 - 3.46)	(0.35 - 8.06)
Missouri	0.41*	0.31*	0.73
	(0.21 - 0.81)	(0.13 - 0.76)	(0.28 - 1.93)
Nebraska	0.53	0	4.81*
	(0.11 - 2.65)	(0.00 - .)	(1.19 - 19.41)
Nevada	0.37	0.46	0
	(0.08 - 1.59)	(0.13 - 1.60)	(0.00 - .)
New Hampshire	2.83***	0.33*	3.79***
	(1.61 - 4.98)	(0.11 - 0.96)	(1.80 - 7.99)
New Jersey	0.27***	0.31***	1.03
	(0.22 - 0.32)	(0.26 - 0.36)	(0.79 - 1.35)
New Mexico	1.05	0.12*	0.67
	(0.46 - 2.42)	(0.02 - 0.87)	(0.09 - 5.15)
New York	0.80***	0.34***	1.83***
	(0.70 - 0.91)	(0.30 - 0.39)	(1.46 - 2.30)
North Carolina	1.14	0.7	0.21***
	(0.63 - 2.07)	(0.33 - 1.50)	(0.09 - 0.53)
Ohio	2.32***	0.35***	4.85***

	(2.00 - 2.68)	(0.29 - 0.43)	(3.80 - 6.20)
Rhode Island	0.52***	0.05***	0.53**
	(0.42 - 0.63)	(0.03 - 0.08)	(0.36 - 0.80)
South Carolina	0.87	2.37	0.63
	(0.38 - 1.99)	(0.97 - 5.78)	(0.20 - 1.96)
South Dakota	2.69	1.58	10.86**
	(0.53 - 13.64)	(0.15 - 16.39)	(2.00 - 58.91)
Tennessee	0	3.39	8.7
	(0.00 - .)	(0.18 - 62.82)	(0.45 - 167.87)
Utah	0.97	1	0.84
	(0.52 - 1.81)	(0.45 - 2.22)	(0.33 - 2.17)
Wyoming	0	0	2.03
	(0.00 - .)	(0.00 - .)	(0.16 - 26.26)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A7. Sensitivity analysis with added covariates: 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	231,025	231,025	231,025
	RRR	RRR	RRR
	(95%CI)	(95%CI)	(95%CI)
Medicaid expansion			
Yes	1.10** (1.04 - 1.16)	2.11*** (1.97 - 2.27)	1.28*** (1.22 - 1.35)
MAT (No= ref)			
Yes	0.64*** (0.62 - 0.66)	0.34*** (0.33 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use (No past month use= ref)			
Some use	0.64*** (0.62 - 0.67)	0.65*** (0.63 - 0.68)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.38)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.00 (0.96 - 1.03)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.85*** (0.82 - 0.88)
Gender (Female=ref)			
Male	0.88*** (0.85 - 0.90)	0.62*** (0.60 - 0.64)	1.31*** (1.28 - 1.35)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.01 (0.96 - 1.07)	1.36*** (1.28 - 1.44)	1.19*** (1.14 - 1.26)
Hispanic	0.90*** (0.85 - 0.95)	1.30*** (1.23 - 1.38)	1.21*** (1.15 - 1.27)
Other	0.88*** (0.82 - 0.95)	1.04 (0.96 - 1.12)	0.96 (0.90 - 1.03)
Education (Less than high school= ref)			
Highschool or higher	0.96**	0.80***	0.78***

	(0.93 - 0.99)	(0.78 - 0.83)	(0.76 - 0.80)
Number of arrests (0=ref)			
1	0.85*** (0.79 - 0.91)	1.19*** (1.12 - 1.28)	2.73*** (2.60 - 2.86)
2 or more	0.83** (0.74 - 0.93)	0.96 (0.83 - 1.11)	1.10 (1.00 - 1.21)
Employment status (Not employed= ref)			
Employed	1.32*** (1.28 - 1.36)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity (No= ref)			
Yes	1.49*** (1.45 - 1.53)	0.93*** (0.90 - 0.96)	0.65*** (0.63 - 0.67)
Homeless (No= ref)			
Yes	1.31*** (1.25 - 1.38)	1.35*** (1.28 - 1.44)	0.61*** (0.58 - 0.65)
Polysubstance use (no= ref)			
One more	0.99 (0.96 - 1.01)	1.02 (0.99 - 1.05)	0.85*** (0.83 - 0.88)
Two or more	0.97 (0.94 - 1.01)	1.06** (1.02 - 1.10)	0.95** (0.92 - 0.98)
Unemployment rate			
Unemployed rate	1.08*** (1.05 - 1.11)	1.11*** (1.08 - 1.15)	1.03* (1.01 - 1.06)
PMDP (No=ref)			
Yes	1.24*** (1.13 - 1.36)	1.44*** (1.31 - 1.59)	0.84*** (0.78 - 0.91)
Year			
2011	0.99 (0.94 - 1.05)	0.77*** (0.72 - 0.82)	1.04 (0.99 - 1.10)
2012	0.99 (0.92 - 1.06)	0.82*** (0.76 - 0.88)	1.19*** (1.12 - 1.27)
2013	0.99 (0.91 - 1.08)	0.81*** (0.74 - 0.88)	1.30*** (1.20 - 1.41)
2014	1.13 (0.99 - 1.29)	0.54*** (0.46 - 0.62)	1.16* (1.02 - 1.31)
2015	1.28** (1.10 - 1.50)	0.66*** (0.56 - 0.79)	1.13 (0.98 - 1.31)
2016	1.13 (0.95 - 1.34)	0.72*** (0.60 - 0.87)	1.18* (1.01 - 1.38)
2017	1.13 (0.94 - 1.35)	0.77** (0.64 - 0.94)	1.04 (0.88 - 1.22)
State			

Alaska	0.62 (0.36 - 1.09)	0.53* (0.31 - 0.91)	1.42 (0.83 - 2.45)
Arizona	0.50** (0.31 - 0.80)	0.12*** (0.08 - 0.20)	0.19*** (0.11 - 0.31)
Arkansas	0.50** (0.29 - 0.85)	0.72 (0.43 - 1.20)	0.6 (0.35 - 1.03)
Colorado	0.56* (0.34 - 0.91)	0.39*** (0.24 - 0.63)	0.78 (0.47 - 1.30)
Connecticut	0.30*** (0.19 - 0.49)	0.10*** (0.06 - 0.16)	0.79 (0.47 - 1.31)
Delaware	1.70* (1.05 - 2.74)	0.08*** (0.04 - 0.13)	1.13 (0.68 - 1.87)
District of Columbia	3.50*** (1.91 - 6.39)	0.39* (0.18 - 0.86)	0.66 (0.32 - 1.39)
Florida	0.39*** (0.24 - 0.63)	0.60* (0.37 - 0.98)	0.87 (0.52 - 1.43)
Hawaii	0.46* (0.23 - 0.94)	0.42** (0.22 - 0.81)	1.19 (0.66 - 2.16)
Idaho	1.93* (1.07 - 3.49)	1.16 (0.63 - 2.15)	5.95*** (3.36 - 10.52)
Illinois	0.87 (0.54 - 1.40)	0.16*** (0.10 - 0.26)	0.73 (0.44 - 1.21)
Indiana	0.69 (0.43 - 1.13)	0.31*** (0.19 - 0.51)	0.75 (0.45 - 1.25)
Iowa	1.08 (0.66 - 1.77)	0.30*** (0.18 - 0.50)	0.78 (0.46 - 1.30)
Kansas	0.99 (0.60 - 1.65)	0.52* (0.31 - 0.88)	1.17 (0.70 - 1.98)
Kentucky	0.72 (0.45 - 1.15)	0.57* (0.36 - 0.93)	1.34 (0.81 - 2.20)
Louisiana	1.14 (0.68 - 1.92)	1.53 (0.92 - 2.54)	1.33 (0.78 - 2.26)
Maine	0.87 (0.54 - 1.40)	0.18*** (0.11 - 0.30)	0.57* (0.34 - 0.94)
Maryland	0.41*** (0.25 - 0.66)	0.30*** (0.19 - 0.49)	0.84 (0.51 - 1.39)
Massachusetts	1.25 (0.77 - 2.03)	0.24*** (0.14 - 0.39)	1.85* (1.11 - 3.07)
Michigan	1.67* (1.04 - 2.68)	0.40*** (0.25 - 0.65)	0.85 (0.52 - 1.41)
Mississippi	0.92 (0.55 - 1.52)	0.23*** (0.13 - 0.41)	0.68 (0.40 - 1.16)
Missouri	0.39*** (0.23 - 0.65)	0.44** (0.26 - 0.73)	0.84 (0.50 - 1.40)
Montana	1.2 (0.72 - 2.01)	0.11*** (0.06 - 0.22)	1.39 (0.82 - 2.36)
Nebraska	1.02 (0.54 - 1.92)	0.49* (0.24 - 0.97)	1.11 (0.61 - 2.02)
Nevada	0.42	0.32*	0.34

	(0.13 - 1.34)	(0.11 - 0.94)	(0.09 - 1.30)
New Hampshire	1.79*	0.14***	1.44
	(1.08 - 2.96)	(0.08 - 0.26)	(0.85 - 2.43)
New Jersey	0.24***	0.42***	1.14
	(0.15 - 0.39)	(0.26 - 0.68)	(0.69 - 1.89)
New Mexico	0.74	0.25*	0.53
	(0.29 - 1.90)	(0.08 - 0.80)	(0.15 - 1.83)
New York	0.8	0.42***	0.55*
	(0.50 - 1.28)	(0.26 - 0.67)	(0.34 - 0.91)
North Carolina	0.97	0.29***	0.65
	(0.61 - 1.55)	(0.18 - 0.46)	(0.40 - 1.07)
North Dakota	1.92	0.33	2.11
	(0.75 - 4.96)	(0.09 - 1.28)	(0.89 - 5.03)
Ohio	1.01	0.42***	1.6
	(0.63 - 1.63)	(0.26 - 0.68)	(0.97 - 2.64)
Oklahoma	0.29***	0.76	1.19
	(0.17 - 0.49)	(0.46 - 1.25)	(0.71 - 1.98)
Pennsylvania	4.88***	1.18	2.50***
	(2.96 - 8.03)	(0.70 - 1.99)	(1.47 - 4.25)
Rhode Island	0.53*	0.09***	0.6
	(0.33 - 0.86)	(0.05 - 0.15)	(0.36 - 1.00)
South Carolina	0.67	0.79	0.62
	(0.41 - 1.10)	(0.48 - 1.29)	(0.37 - 1.03)
South Dakota	1.31	0.76	1.62
	(0.65 - 2.61)	(0.36 - 1.62)	(0.85 - 3.10)
Tennessee	1.32	0.39***	3.20***
	(0.79 - 2.20)	(0.23 - 0.68)	(1.91 - 5.38)
Utah	1.07	0.74	2.58***
	(0.66 - 1.73)	(0.45 - 1.22)	(1.55 - 4.28)
Washington	0.93	1.08	1.07
	(0.58 - 1.50)	(0.67 - 1.75)	(0.65 - 1.77)
Wyoming	0.99	0.40*	0.74
	(0.48 - 2.00)	(0.17 - 0.93)	(0.37 - 1.49)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A8. Sensitivity analysis with added covariates: DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion	0.92 (0.57 - 1.48)	1.04 (0.64 - 1.68)	1.07 (0.64 - 1.76)
Post expansion	1.09 (0.91 - 1.31)	0.64*** (0.53 - 0.78)	1.00 (0.84 - 1.18)
Expansion * Post expansion	1.11*** (1.04 - 1.17)	2.25*** (2.09 - 2.41)	1.29*** (1.23 - 1.37)
MAT (No= ref)			
Yes	0.65*** (0.63 - 0.67)	0.33*** (0.32 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.63 - 0.69)	0.38*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.39)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	0.99 (0.96 - 1.02)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.84*** (0.81 - 0.88)
Gender			
Male	0.88*** (0.86 - 0.90)	0.62*** (0.60 - 0.63)	1.31*** (1.28 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02 (0.97 - 1.07)	1.36*** (1.28 - 1.45)	1.19*** (1.13 - 1.26)
Hispanic	0.90*** (0.85 - 0.95)	1.32*** (1.24 - 1.40)	1.21*** (1.15 - 1.27)
Other	0.89** (0.82 - 0.96)	1.04 (0.96 - 1.13)	0.98 (0.92 - 1.06)
Education			
Highschool or higher	0.96* (0.94 - 0.99)	0.81*** (0.78 - 0.84)	0.78*** (0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83*** (0.78 - 0.89)	1.20*** (1.12 - 1.28)	2.73*** (2.60 - 2.87)
2 or more	0.85** (0.76 - 0.95)	0.96 (0.83 - 1.11)	1.09 (0.99 - 1.21)
Employment status			
Employed	1.33***	1.14***	0.93***

	(1.29 - 1.37)	(1.10 - 1.18)	(0.91 - 0.96)
Comorbidity			
Yes	1.51*** (1.47 - 1.55)	0.92*** (0.89 - 0.95)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.27 - 1.40)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	0.99 (0.97 - 1.02)	1.01 (0.98 - 1.05)	0.85*** (0.82 - 0.87)
Two or more	0.98 (0.95 - 1.02)	1.05** (1.02 - 1.09)	0.94*** (0.91 - 0.97)
Unemployment rate			
Unemployed rate	1.08*** (1.05 - 1.11)	1.09*** (1.06 - 1.12)	1.03* (1.00 - 1.06)
PMDP (No= ref)			
Yes	1.24*** (1.13 - 1.36)	1.50*** (1.36 - 1.65)	0.85*** (0.78 - 0.92)
Year			
2011	0.99 (0.94 - 1.05)	0.75*** (0.70 - 0.80)	1.03 (0.98 - 1.09)
2012	0.97 (0.90 - 1.04)	0.77*** (0.71 - 0.83)	1.18*** (1.10 - 1.26)
2013	0.98 (0.90 - 1.07)	0.74*** (0.68 - 0.82)	1.28*** (1.18 - 1.39)
2014	1 (0.93 - 1.08)	0.70*** (0.65 - 0.76)	1.12*** (1.05 - 1.20)
2015	1.14*** (1.08 - 1.21)	0.86*** (0.81 - 0.91)	1.10*** (1.04 - 1.15)
2016	1 (0.95 - 1.05)	0.94* (0.89 - 1.00)	1.14*** (1.09 - 1.20)
State			
Arizona	0.54*** (0.49 - 0.60)	0.11*** (0.10 - 0.12)	0.17*** (0.16 - 0.19)
Arkansas	0.54*** (0.42 - 0.70)	0.65*** (0.53 - 0.79)	0.56*** (0.44 - 0.70)
Colorado	0.60*** (0.52 - 0.69)	0.34*** (0.30 - 0.39)	0.73*** (0.64 - 0.83)
Connecticut	0.33*** (0.28 - 0.38)	0.09*** (0.07 - 0.11)	0.73*** (0.65 - 0.83)
Delaware	1.84*** (1.63 - 2.07)	0.07*** (0.05 - 0.09)	1.05 (0.94 - 1.19)
District of Columbia	3.81*** (2.58 - 5.62)	0.37** (0.20 - 0.70)	0.62 (0.36 - 1.08)
Florida	0.39*** (0.24 - 0.63)	0.60* (0.37 - 0.97)	0.87 (0.52 - 1.43)
Hawaii	0.50* (0.29 - 0.85)	0.37*** (0.24 - 0.57)	1.09 (0.79 - 1.52)
Idaho	1.93* (1.63 - 2.23)	1.11 (0.89 - 1.33)	5.90*** (4.41 - 7.89)

	(1.07 - 3.49)	(0.60 - 2.05)	(3.34 - 10.44)
Illinois	0.94	0.15***	0.69***
	(0.84 - 1.05)	(0.13 - 0.17)	(0.62 - 0.77)
Iowa	1.16	0.26***	0.72***
	(0.99 - 1.37)	(0.21 - 0.32)	(0.61 - 0.85)
Kansas	0.99	0.48**	1.16
	(0.60 - 1.64)	(0.29 - 0.81)	(0.69 - 1.96)
Kentucky	0.78***	0.53***	1.25***
	(0.71 - 0.85)	(0.49 - 0.57)	(1.15 - 1.36)
Maine	0.87	0.17***	0.56*
	(0.54 - 1.40)	(0.10 - 0.28)	(0.34 - 0.93)
Maryland	0.44***	0.28***	0.78***
	(0.39 - 0.50)	(0.24 - 0.31)	(0.70 - 0.87)
Massachusetts	1.35***	0.21***	1.71***
	(1.18 - 1.55)	(0.17 - 0.26)	(1.50 - 1.95)
Michigan	1.82***	0.37***	0.80***
	(1.65 - 2.01)	(0.33 - 0.41)	(0.72 - 0.89)
Mississippi	0.93	0.24***	0.69
	(0.56 - 1.55)	(0.13 - 0.41)	(0.41 - 1.17)
Missouri	0.39***	0.44**	0.83
	(0.23 - 0.65)	(0.26 - 0.73)	(0.50 - 1.40)
Nebraska	1.01	0.44*	1.09
	(0.53 - 1.91)	(0.22 - 0.88)	(0.60 - 1.99)
Nevada	0.46	0.30*	0.32
	(0.16 - 1.31)	(0.11 - 0.79)	(0.09 - 1.12)
New Hampshire	1.94***	0.13***	1.33**
	(1.60 - 2.35)	(0.09 - 0.18)	(1.11 - 1.58)
New Jersey	0.26***	0.39***	1.07
	(0.23 - 0.30)	(0.35 - 0.43)	(0.96 - 1.19)
New Mexico	0.79	0.23**	0.49
	(0.35 - 1.80)	(0.08 - 0.65)	(0.16 - 1.52)
New York	0.86**	0.38***	0.51***
	(0.79 - 0.94)	(0.35 - 0.41)	(0.47 - 0.56)
North Carolina	0.98	0.28***	0.65
	(0.61 - 1.56)	(0.17 - 0.45)	(0.40 - 1.06)
North Dakota	2.06	0.27*	1.91
	(0.90 - 4.69)	(0.08 - 0.95)	(0.94 - 3.90)
Ohio	1.1	0.38***	1.49***
	(1.00 - 1.22)	(0.35 - 0.42)	(1.36 - 1.64)
Oklahoma	0.29***	0.71	1.18
	(0.17 - 0.49)	(0.43 - 1.18)	(0.70 - 1.97)
Pennsylvania	0.57***	0.08***	0.56***
	(0.49 - 0.67)	(0.06 - 0.11)	(0.47 - 0.66)
Rhode Island	0.67	0.77	0.62
	(0.41 - 1.11)	(0.47 - 1.25)	(0.37 - 1.03)
South Carolina	1.3	0.69	1.59
	(0.65 - 2.60)	(0.33 - 1.48)	(0.83 - 3.04)
South Dakota	1.33	0.38***	3.20***
	(0.80 - 2.21)	(0.22 - 0.66)	(1.91 - 5.38)

Utah	1.06 (0.65 - 1.72)	0.68 (0.42 - 1.12)	2.55*** (1.53 - 4.23)
Wyoming	1	0.39*	0.74
Arizona	(0.49 - 2.03)	(0.17 - 0.91)	(0.37 - 1.48)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A9. Sensitivity analysis with lagged DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	AOR	AOR	AOR
	(95% CI)	(95% CI)	(95% CI)
Expansion	0.84	0.91	1.03
	(0.52 - 1.35)	(0.57 - 1.48)	(0.62 - 1.71)
Post expansion year 2014	0.91*	0.44***	1.16***
	(0.84 - 0.98)	(0.39 - 0.49)	(1.07 - 1.26)
Expansion * Post expansion Year 0 (or year 2014)	1.03	1.78***	1.04
	(0.94 - 1.13)	(1.57 - 2.01)	(0.96 - 1.13)
Post expansion year 1	1.08	1.09	0.88*
	(0.98 - 1.20)	(0.94 - 1.27)	(0.80 - 0.97)
Expansion* Post expansion year 1	0.98	1.04	1.12
	(0.87 - 1.10)	(0.88 - 1.23)	(1.00 - 1.25)
Post expansion year 2	0.74***	0.87*	1.00
	(0.67 - 0.82)	(0.76 - 1.00)	(0.91 - 1.10)
Expansion* Post expansion year 2	1.19**	1.26**	1.02
	(1.06 - 1.33)	(1.08 - 1.48)	(0.91 - 1.14)
Post expansion year 3	0.90**	0.83**	0.67***
	(0.83 - 0.97)	(0.74 - 0.93)	(0.62 - 0.72)
Expansion* Post expansion year 3	1.15**	1.35***	1.50***
	(1.04 - 1.27)	(1.19 - 1.54)	(1.37 - 1.65)
MAT (No= ref)			
Yes	0.65***	0.33***	0.14***
	(0.63 - 0.67)	(0.32 - 0.34)	(0.13 - 0.14)
Frequency of use			
Some use	0.64***	0.66***	0.38***
	(0.62 - 0.67)	(0.63 - 0.69)	(0.37 - 0.40)
Daily use	0.51***	0.38***	0.16***
	(0.50 - 0.53)	(0.36 - 0.39)	(0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00	0.99	0.99
	(0.97 - 1.03)	(0.96 - 1.03)	(0.96 - 1.01)
45-64	1.11***	0.77***	0.84***
	(1.07 - 1.15)	(0.74 - 0.81)	(0.81 - 0.88)
Gender			
Male	0.88***	0.62***	1.31***
	(0.85 - 0.90)	(0.60 - 0.63)	(1.28 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02	1.37***	1.20***
	(0.97 - 1.07)	(1.29 - 1.46)	(1.14 - 1.26)

Hispanic	0.89*** (0.84 - 0.94)	1.31*** (1.24 - 1.39)	1.21*** (1.14 - 1.27)
Other	0.87*** (0.81 - 0.94)	1.02 (0.95 - 1.11)	0.97 (0.91 - 1.04)
Education			
Highschool or higher	0.96* (0.94 - 0.99)	0.81*** (0.79 - 0.84)	0.78*** (0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83*** (0.78 - 0.89)	1.20*** (1.12 - 1.28)	2.74*** (2.61 - 2.87)
2 or more	0.86* (0.77 - 0.97)	0.97 (0.83 - 1.12)	1.09 (0.99 - 1.20)
Employment status			
Employed	1.33*** (1.29 - 1.37)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity			
Yes	1.50*** (1.46 - 1.54)	0.91*** (0.89 - 0.94)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.27 - 1.41)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	1.00 (0.97 - 1.03)	1.02 (0.99 - 1.06)	0.85*** (0.83 - 0.88)
Two or more	0.99 (0.96 - 1.03)	1.07*** (1.03 - 1.11)	0.95** (0.92 - 0.98)
Year			
2011	0.96 (0.91 - 1.01)	0.75*** (0.71 - 0.80)	0.99 (0.95 - 1.05)
2012	0.89*** (0.84 - 0.93)	0.72*** (0.68 - 0.77)	1.11*** (1.05 - 1.16)
2013	0.85*** (0.81 - 0.90)	0.67*** (0.63 - 0.71)	1.17*** (1.12 - 1.23)
State			
Arizona	0.56*** (0.51 - 0.62)	0.12*** (0.11 - 0.13)	0.17*** (0.15 - 0.19)
Arkansas	0.47*** (0.36 - 0.61)	0.54*** (0.44 - 0.65)	0.56*** (0.45 - 0.71)
Colorado	0.55*** (0.48 - 0.64)	0.31*** (0.28 - 0.36)	0.68*** (0.60 - 0.77)
Connecticut	0.33*** (0.28 - 0.39)	0.09*** (0.07 - 0.11)	0.71*** (0.62 - 0.80)
Delaware	1.63*** (1.45 - 1.84)	0.06*** (0.05 - 0.08)	1.04 (0.92 - 1.16)
District of Columbia	3.81*** (2.60 - 5.60)	0.36** (0.19 - 0.68)	0.66 (0.38 - 1.13)
Florida	0.36*** (0.23 - 0.59)	0.51** (0.32 - 0.83)	0.86 (0.52 - 1.43)

Hawaii	0.42** (0.25 - 0.73)	0.31*** (0.20 - 0.48)	0.99 (0.72 - 1.38)
Idaho	1.66 (0.92 - 2.99)	0.9 (0.49 - 1.67)	5.33*** (3.02 - 9.41)
Illinois	1 (0.89 - 1.11)	0.16*** (0.14 - 0.18)	0.67*** (0.60 - 0.74)
Iowa	0.98 (0.84 - 1.14)	0.22*** (0.18 - 0.26)	0.65*** (0.55 - 0.75)
Kansas	0.79 (0.48 - 1.30)	0.35*** (0.21 - 0.59)	1.09 (0.65 - 1.83)
Kentucky	0.80*** (0.73 - 0.87)	0.55*** (0.51 - 0.59)	1.21*** (1.11 - 1.32)
Maine	0.74 (0.46 - 1.20)	0.14*** (0.08 - 0.23)	0.50** (0.30 - 0.83)
Maryland	0.37*** (0.33 - 0.42)	0.21*** (0.19 - 0.24)	0.80*** (0.72 - 0.89)
Massachusetts	1.27*** (1.11 - 1.45)	0.20*** (0.16 - 0.24)	1.62*** (1.43 - 1.84)
Michigan	1.96*** (1.78 - 2.15)	0.41*** (0.37 - 0.45)	0.79*** (0.71 - 0.87)
Mississippi	0.97 (0.58 - 1.62)	0.25*** (0.14 - 0.43)	0.69 (0.41 - 1.17)
Missouri	0.28*** (0.17 - 0.47)	0.25*** (0.15 - 0.42)	0.9 (0.54 - 1.50)
Nebraska	0.73 (0.39 - 1.37)	0.29*** (0.14 - 0.57)	0.93 (0.51 - 1.69)
Nevada	0.5 (0.17 - 1.44)	0.33* (0.12 - 0.87)	0.32 (0.09 - 1.12)
New Hampshire	1.56*** (1.31 - 1.87)	0.10*** (0.07 - 0.14)	1.25** (1.06 - 1.48)
New Jersey	0.26*** (0.23 - 0.30)	0.38*** (0.34 - 0.42)	1.04 (0.94 - 1.16)
New Mexico	0.76 (0.34 - 1.73)	0.22** (0.08 - 0.64)	0.45 (0.14 - 1.41)
New York	0.86*** (0.79 - 0.94)	0.38*** (0.35 - 0.41)	0.50*** (0.46 - 0.54)
North Carolina	0.98 (0.61 - 1.56)	0.28*** (0.17 - 0.45)	0.62 (0.38 - 1.02)
North Dakota	1.44 (0.64 - 3.23)	0.19** (0.05 - 0.65)	1.6 (0.80 - 3.22)
Ohio	1.11* (1.00 - 1.23)	0.40*** (0.36 - 0.44)	1.44*** (1.31 - 1.58)
Oklahoma	0.24*** (0.14 - 0.41)	0.58* (0.35 - 0.95)	1.06 (0.63 - 1.76)
Rhode Island	0.63*** (0.55 - 0.73)	0.09*** (0.07 - 0.12)	0.56*** (0.47 - 0.66)
South Carolina	0.67 (0.41 - 1.10)	0.76 (0.46 - 1.24)	0.59* (0.35 - 0.98)
South Dakota	0.95	0.46*	1.39

Tennessee	(0.48 - 1.90) 1.25	(0.21 - 0.97) 0.34***	(0.73 - 2.64) 2.97***
Utah	(0.75 - 2.08) 0.85	(0.20 - 0.59) 0.52**	(1.77 - 4.98) 2.22**
Wyoming	(0.52 - 1.37) 0.93	(0.32 - 0.85) 0.36*	(1.34 - 3.67) 0.7
	(0.46 - 1.89)	(0.16 - 0.83)	(0.35 - 1.40)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A10. Sensitivity analysis that added Waiver 1115 Demonstrations: 2WFE model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	231,025	231,025	231,025
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Medicaid expansion			
Yes	1.17*** (1.11 - 1.24)	2.26*** (2.11 - 2.42)	1.31*** (1.24 - 1.38)
Waiver 1115 Demonstrations			
Yes	1.04 (0.88 - 1.23)	1.21* (1.04 - 1.41)	1.03 (0.89 - 1.18)
MAT (No= ref)			
Yes	0.64*** (0.62 - 0.66)	0.34*** (0.33 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use (No past month use= ref)			
Some use	0.64*** (0.62 - 0.67)	0.65*** (0.63 - 0.68)	0.39*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.37*** (0.36 - 0.38)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	1.00 (0.97 - 1.03)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.85*** (0.82 - 0.88)
Gender (Female=ref)			
Male	0.88*** (0.85 - 0.90)	0.62*** (0.60 - 0.64)	1.31*** (1.28 - 1.35)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.01 (0.96 - 1.07)	1.35*** (1.27 - 1.44)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.85 - 0.95)	1.30*** (1.22 - 1.37)	1.21*** (1.15 - 1.27)
Other	0.87*** (0.81 - 0.94)	1.03 (0.95 - 1.11)	0.96 (0.90 - 1.03)
Education (Less than high school= ref)			
Highschool or higher	0.96**	0.80***	0.78***

	(0.93 - 0.99)	(0.78 - 0.83)	(0.76 - 0.80)
Number of arrests (0= ref)			
1	0.85*** (0.79 - 0.91)	1.19*** (1.11 - 1.27)	2.73*** (2.60 - 2.86)
2 or more	0.85** (0.76 - 0.95)	0.97 (0.84 - 1.12)	1.09 (0.99 - 1.20)
Employment status (Not employed= ref)			
Employed	1.32*** (1.28 - 1.36)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity (No= ref)			
Yes	1.49*** (1.45 - 1.53)	0.92*** (0.89 - 0.95)	0.65*** (0.63 - 0.67)
Homeless (No= ref)			
Yes	1.31*** (1.25 - 1.38)	1.35*** (1.28 - 1.43)	0.61*** (0.58 - 0.65)
Polysubstance use (no= ref)			
One more	0.99 (0.96 - 1.02)	1.02 (0.99 - 1.06)	0.85*** (0.83 - 0.88)
Two or more	0.98 (0.95 - 1.01)	1.07*** (1.03 - 1.11)	0.95** (0.92 - 0.98)
Year			
2011	0.96 (0.91 - 1.01)	0.76*** (0.72 - 0.80)	1 (0.95 - 1.05)
2012	0.90*** (0.85 - 0.95)	0.73*** (0.69 - 0.77)	1.11*** (1.06 - 1.16)
2013	0.86*** (0.81 - 0.90)	0.68*** (0.64 - 0.72)	1.18*** (1.12 - 1.23)
2014	0.83*** (0.78 - 0.88)	0.37*** (0.34 - 0.40)	0.98 (0.93 - 1.04)
2015	0.88*** (0.82 - 0.93)	0.41*** (0.38 - 0.44)	0.93* (0.88 - 0.99)
2016	0.74*** (0.70 - 0.79)	0.43*** (0.40 - 0.46)	0.96 (0.90 - 1.02)
2017	0.71*** (0.67 - 0.75)	0.44*** (0.41 - 0.47)	0.83*** (0.78 - 0.87)
State			
Alaska	0.62 (0.35 - 1.08)	0.54* (0.31 - 0.92)	1.44 (0.84 - 2.48)
Arizona	0.48** (0.30 - 0.77)	0.12*** (0.07 - 0.19)	0.19*** (0.11 - 0.31)
Arkansas	0.39*** (0.23 - 0.67)	0.48** (0.28 - 0.80)	0.6 (0.35 - 1.04)

Colorado	0.47** (0.29 - 0.77)	0.32*** (0.19 - 0.52)	0.74 (0.44 - 1.22)
Connecticut	0.29*** (0.18 - 0.47)	0.09*** (0.05 - 0.15)	0.78 (0.47 - 1.29)
Delaware	1.34 (0.81 - 2.22)	0.05*** (0.03 - 0.09)	1.09 (0.65 - 1.84)
District of Columbia	3.26*** (1.79 - 5.95)	0.37* (0.17 - 0.80)	0.71 (0.34 - 1.49)
Florida	0.37*** (0.23 - 0.60)	0.55* (0.34 - 0.90)	0.91 (0.55 - 1.50)
Hawaii	0.36** (0.18 - 0.74)	0.31*** (0.16 - 0.59)	1.08 (0.60 - 1.95)
Idaho	1.71 (0.95 - 3.07)	0.99 (0.53 - 1.83)	5.64*** (3.19 - 9.96)
Illinois	0.86 (0.54 - 1.39)	0.16*** (0.10 - 0.26)	0.73 (0.44 - 1.21)
Indiana	0.65 (0.40 - 1.06)	0.29*** (0.18 - 0.48)	0.73 (0.44 - 1.22)
Iowa	0.84 (0.52 - 1.36)	0.22*** (0.13 - 0.36)	0.7 (0.42 - 1.17)
Kansas	0.79 (0.48 - 1.30)	0.37*** (0.22 - 0.62)	1.11 (0.66 - 1.87)
Kentucky	0.68 (0.43 - 1.09)	0.55* (0.34 - 0.88)	1.32 (0.80 - 2.16)
	1 (0.60 - 1.68)	1.3 (0.78 - 2.15)	1.25 (0.74 - 2.12)
Maine	0.77 (0.48 - 1.24)	0.15*** (0.09 - 0.25)	0.54* (0.32 - 0.89)
Maryland	0.30*** (0.18 - 0.50)	0.17*** (0.10 - 0.29)	0.83 (0.50 - 1.40)
Massachusetts	1.04 (0.62 - 1.73)	0.16*** (0.10 - 0.28)	1.70* (1.01 - 2.88)
Michigan	1.68* (1.05 - 2.69)	0.41*** (0.26 - 0.67)	0.86 (0.52 - 1.42)
Mississippi	0.97 (0.58 - 1.61)	0.25*** (0.14 - 0.44)	0.7 (0.41 - 1.19)
Missouri	0.29*** (0.17 - 0.48)	0.28*** (0.17 - 0.46)	0.96 (0.58 - 1.59)
Montana	0.92 (0.55 - 1.53)	0.08*** (0.04 - 0.15)	1.34 (0.79 - 2.26)
Nebraska	0.75 (0.40 - 1.40)	0.31*** (0.16 - 0.62)	0.99 (0.55 - 1.80)
Nevada	0.43 (0.14 - 1.35)	0.33* (0.11 - 0.97)	0.35 (0.09 - 1.32)
New Hampshire	1.34 (0.81 - 2.20)	0.10*** (0.06 - 0.18)	1.37 (0.81 - 2.29)
New Jersey	0.22*** (0.13 - 0.36)	0.33*** (0.20 - 0.55)	1.13 (0.68 - 1.88)
New Mexico	0.66	0.22*	0.5

	(0.26 - 1.69)	(0.07 - 0.71)	(0.14 - 1.71)
New York	0.74	0.38***	0.53*
	(0.46 - 1.18)	(0.24 - 0.62)	(0.33 - 0.88)
North Carolina	0.98	0.30***	0.65
	(0.61 - 1.57)	(0.18 - 0.47)	(0.40 - 1.07)
North Dakota	1.22	0.19*	1.73
	(0.48 - 3.10)	(0.05 - 0.71)	(0.74 - 4.06)
Ohio	0.94	0.39***	1.55
	(0.59 - 1.51)	(0.24 - 0.64)	(0.94 - 2.56)
Oklahoma	0.25***	0.62	1.11
	(0.14 - 0.42)	(0.38 - 1.02)	(0.67 - 1.86)
Pennsylvania	4.50***	1.02	2.48***
	(2.72 - 7.44)	(0.60 - 1.72)	(1.46 - 4.22)
Rhode Island	0.52*	0.08***	0.59
	(0.31 - 0.87)	(0.04 - 0.13)	(0.35 - 1.01)
South Carolina	0.67	0.82	0.62
	(0.41 - 1.11)	(0.50 - 1.33)	(0.37 - 1.03)
South Dakota	0.97	0.5	1.48
	(0.49 - 1.94)	(0.23 - 1.05)	(0.78 - 2.82)
Tennessee	1.27	0.37***	3.14***
	(0.76 - 2.12)	(0.22 - 0.65)	(1.87 - 5.28)
Utah	0.88	0.57*	2.37***
	(0.54 - 1.42)	(0.35 - 0.93)	(1.43 - 3.91)
Washington	0.85	0.97	1.06
	(0.53 - 1.37)	(0.60 - 1.57)	(0.64 - 1.75)
Wyoming		0.94	0.38*
		(0.46 - 1.92)	(0.17 - 0.88)

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

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR.

Confidence Interval = CI.

Table 4-A11. Sensitivity analysis that added Waiver 1115 Demonstrations: DID model for non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272 RRR (95% CI)	225,272 RRR (95% CI)	225,272 RRR (95% CI)
Expansion	0.84 (0.52 - 1.36)	0.94 (0.58 - 1.52)	1.06 (0.64 - 1.75)
Post expansion	0.70*** (0.66 - 0.74)	0.42*** (0.39 - 0.45)	0.82*** (0.77 - 0.87)
Expansion * Post expansion	1.18*** (1.12 - 1.24)	2.38*** (2.22 - 2.54)	1.31*** (1.25 - 1.38)
Waiver 1115 Demonstrations			
Yes	1.21 (0.97 - 1.50)	1.16 (0.98 - 1.36)	1.02 (0.88 - 1.19)
MAT (No= ref)			
Yes	0.65*** (0.63 - 0.67)	0.33*** (0.32 - 0.35)	0.14*** (0.13 - 0.14)
Frequency of use			
Some use	0.64*** (0.62 - 0.67)	0.66*** (0.63 - 0.69)	0.38*** (0.37 - 0.40)
Daily use	0.51*** (0.50 - 0.53)	0.38*** (0.36 - 0.39)	0.16*** (0.16 - 0.17)
Age (18-29= ref)			
30-44	1.00 (0.97 - 1.03)	0.99 (0.96 - 1.03)	0.99 (0.96 - 1.01)
45-64	1.11*** (1.07 - 1.15)	0.77*** (0.74 - 0.81)	0.84*** (0.81 - 0.88)
Gender			
Male	0.88*** (0.85 - 0.90)	0.62*** (0.60 - 0.63)	1.31*** (1.28 - 1.35)
Race/ethnicity			
Non-Hispanic Black	1.02 (0.96 - 1.07)	1.36*** (1.28 - 1.45)	1.19*** (1.13 - 1.26)
Hispanic	0.89*** (0.84 - 0.94)	1.31*** (1.24 - 1.39)	1.21*** (1.15 - 1.27)
Other	0.88*** (0.82 - 0.95)	1.04 (0.96 - 1.12)	0.98 (0.92 - 1.06)
Education			
Highschool or higher	0.96* (0.94 - 0.99)	0.81*** (0.78 - 0.84)	0.78*** (0.76 - 0.80)
Number of arrests (0=ref)			
1	0.83*** (0.78 - 0.89)	1.20*** (1.12 - 1.28)	2.73*** (2.60 - 2.87)
2 or more	0.86* (0.82 - 0.90)	0.96 (0.92 - 1.00)	1.08 (1.04 - 1.12)

	(0.77 - 0.97)	(0.83 - 1.12)	(0.98 - 1.20)
Employment status			
Employed	1.33*** (1.29 - 1.37)	1.14*** (1.10 - 1.18)	0.93*** (0.91 - 0.96)
Comorbidity			
Yes	1.50*** (1.46 - 1.54)	0.91*** (0.89 - 0.94)	0.65*** (0.63 - 0.67)
Homeless			
Yes	1.33*** (1.26 - 1.40)	1.35*** (1.27 - 1.43)	0.61*** (0.57 - 0.65)
Polysubstance use			
One more	1.00 (0.97 - 1.03)	1.02 (0.98 - 1.05)	0.85*** (0.82 - 0.87)
Two or more	0.99 (0.95 - 1.02)	1.06** (1.02 - 1.10)	0.94*** (0.91 - 0.97)
Year			
2011	0.95 (0.91 - 1.00)	0.75*** (0.71 - 0.80)	0.99 (0.95 - 1.04)
2012	0.88*** (0.84 - 0.93)	0.72*** (0.68 - 0.76)	1.10*** (1.05 - 1.16)
2013	0.85*** (0.81 - 0.90)	0.66*** (0.63 - 0.70)	1.17*** (1.11 - 1.23)
2014	1.17*** (1.11 - 1.22)	0.83*** (0.78 - 0.88)	1.19*** (1.13 - 1.24)
2015	1.23*** (1.17 - 1.29)	0.93** (0.88 - 0.98)	1.13*** (1.07 - 1.18)
2016	1.04 (0.99 - 1.09)	0.98 (0.93 - 1.04)	1.16*** (1.11 - 1.21)
State			
Arizona	0.57*** (0.52 - 0.63)	0.12*** (0.11 - 0.13)	0.17*** (0.16 - 0.19)
Arkansas	0.43*** (0.32 - 0.57)	0.50*** (0.40 - 0.62)	0.56*** (0.44 - 0.72)
Colorado	0.56*** (0.49 - 0.65)	0.32*** (0.28 - 0.37)	0.69*** (0.61 - 0.78)
Connecticut	0.34*** (0.29 - 0.40)	0.09*** (0.08 - 0.11)	0.73*** (0.64 - 0.83)
Delaware	1.37* (1.07 - 1.75)	0.05*** (0.04 - 0.07)	1.03 (0.85 - 1.25)
District of Columbia	3.88*** (2.64 - 5.69)	0.37** (0.20 - 0.69)	0.67 (0.39 - 1.16)
Florida	0.37*** (0.23 - 0.60)	0.54* (0.33 - 0.87)	0.91 (0.55 - 1.50)
Hawaii	0.43** (0.25 - 0.73)	0.32*** (0.21 - 0.49)	1.01 (0.73 - 1.40)
Idaho	1.71 (0.95 - 3.08)	0.97 (0.53 - 1.80)	5.64*** (3.20 - 9.97)
Illinois	1.02 (0.92 - 1.13)	0.16*** (0.15 - 0.19)	0.69*** (0.62 - 0.77)

Iowa	0.99 (0.85 - 1.16)	0.22*** (0.18 - 0.27)	0.66*** (0.56 - 0.77)
Kansas	0.79 (0.48 - 1.30)	0.36*** (0.22 - 0.60)	1.12 (0.67 - 1.87)
Kentucky	0.81*** (0.74 - 0.89)	0.56*** (0.52 - 0.61)	1.24*** (1.14 - 1.34)
Maine	0.77 (0.48 - 1.24)	0.15*** (0.09 - 0.25)	0.53* (0.32 - 0.89)
Maryland	0.31*** (0.24 - 0.39)	0.19*** (0.15 - 0.23)	0.79* (0.65 - 0.95)
Massachusetts	1.06 (0.82 - 1.37)	0.17*** (0.14 - 0.22)	1.61*** (1.32 - 1.96)
Michigan	1.99*** (1.81 - 2.19)	0.42*** (0.38 - 0.46)	0.81*** (0.73 - 0.89)
Mississippi	0.98 (0.59 - 1.63)	0.25*** (0.14 - 0.44)	0.7 (0.41 - 1.19)
Missouri	0.29*** (0.18 - 0.48)	0.27*** (0.16 - 0.45)	0.96 (0.58 - 1.59)
Nebraska	0.75 (0.40 - 1.41)	0.31*** (0.16 - 0.61)	0.99 (0.55 - 1.80)
Nevada	0.51 (0.18 - 1.45)	0.33* (0.13 - 0.89)	0.33 (0.09 - 1.14)
New Hampshire	1.60*** (1.33 - 1.91)	0.10*** (0.07 - 0.14)	1.29** (1.09 - 1.52)
New Jersey	0.23*** (0.19 - 0.29)	0.35*** (0.30 - 0.41)	1.06 (0.91 - 1.24)
New Mexico	0.77 (0.34 - 1.76)	0.23** (0.08 - 0.65)	0.46 (0.15 - 1.44)
New York	0.87** (0.80 - 0.95)	0.39*** (0.36 - 0.42)	0.50*** (0.46 - 0.55)
North Carolina	0.99 (0.62 - 1.58)	0.29*** (0.18 - 0.46)	0.65 (0.40 - 1.06)
North Dakota	1.45 (0.64 - 3.25)	0.19** (0.05 - 0.66)	1.62 (0.81 - 3.26)
Ohio	1.12* (1.01 - 1.24)	0.40*** (0.36 - 0.44)	1.46*** (1.33 - 1.60)
Oklahoma	0.25*** (0.15 - 0.42)	0.61 (0.37 - 1.00)	1.12 (0.67 - 1.86)
Rhode Island	0.53*** (0.41 - 0.69)	0.08*** (0.06 - 0.11)	0.56*** (0.44 - 0.69)
South Carolina	0.68 (0.41 - 1.11)	0.79 (0.48 - 1.29)	0.62 (0.37 - 1.03)
South Dakota	0.98 (0.49 - 1.95)	0.49 (0.23 - 1.03)	1.48 (0.78 - 2.81)
Tennessee	1.28 (0.77 - 2.13)	0.37*** (0.21 - 0.64)	3.15*** (1.88 - 5.30)
Utah	0.88 (0.54 - 1.42)	0.56* (0.34 - 0.91)	2.37*** (1.43 - 3.92)
Wyoming	0.96	0.38*	0.73

(0.47 - 1.94)

(0.16 - 0.87)

(0.37 - 1.46)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A12. 2WFE model for non-intensive outpatient treatment for OUD with more than one treatment episode

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	518,154	518,154	518,154
	RRR	RRR	RRR
	(95%CI)	(95%CI)	(95%CI)
Medicaid expansion			
Yes	0.91*** (0.88 - 0.95)	1.34*** (1.26 - 1.42)	0.96 (0.92 - 1.01)
MAT (No= ref)			
Yes	0.53*** (0.52 - 0.54)	0.29*** (0.28 - 0.30)	0.13*** (0.13 - 0.13)
Frequency of use (No past month use= ref)			
Some use	0.52*** (0.51 - 0.53)	0.57*** (0.55 - 0.58)	0.36*** (0.35 - 0.37)
Daily use	0.49*** (0.49 - 0.50)	0.38*** (0.37 - 0.39)	0.19*** (0.19 - 0.20)
Age (18-29= ref)			
30-44	0.94*** (0.92 - 0.95)	1.04** (1.02 - 1.07)	0.90*** (0.88 - 0.92)
45-64	0.92*** (0.89 - 0.94)	0.86*** (0.84 - 0.89)	0.67*** (0.65 - 0.69)
Gender (Female=ref)			
Male	0.96*** (0.94 - 0.97)	0.74*** (0.72 - 0.75)	1.40*** (1.37 - 1.42)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.22*** (1.18 - 1.25)	1.36*** (1.31 - 1.42)	1.01 (0.97 - 1.04)
Hispanic	0.90*** (0.87 - 0.92)	1.24*** (1.20 - 1.28)	1.11*** (1.08 - 1.14)
Other	0.80*** (0.77 - 0.84)	0.84*** (0.80 - 0.89)	0.87*** (0.83 - 0.91)
Education (Less than high school= ref)			
Highschool or higher	1.00 (0.98 - 1.01)	0.83*** (0.81 - 0.85)	0.86*** (0.85 - 0.88)

Number of arrests (0= ref)			
1	0.79*** (0.76 - 0.82)	1.11*** (1.06 - 1.17)	2.35*** (2.27 - 2.43)
2 or more	0.67*** (0.62 - 0.73)	0.77*** (0.69 - 0.87)	1.33*** (1.24 - 1.44)
Employment status (Not employed= ref)			
Employed	1.32*** (1.29 - 1.35)	1.24*** (1.21 - 1.27)	0.95*** (0.93 - 0.97)
Comorbidity (No= ref)			
Yes	1.22*** (1.20 - 1.24)	0.97** (0.95 - 0.99)	0.76*** (0.75 - 0.77)
Homeless (No= ref)			
Yes	1.07*** (1.04 - 1.11)	1.39*** (1.34 - 1.44)	0.65*** (0.63 - 0.68)
Polysubstance use (no= ref)			
One more	1.00 (0.98 - 1.01)	1.11*** (1.09 - 1.14)	1.06*** (1.04 - 1.08)
Two or more	1.06*** (1.04 - 1.08)	1.24*** (1.21 - 1.27)	1.18*** (1.15 - 1.20)
Year			
2011	0.94*** (0.91 - 0.97)	0.86*** (0.83 - 0.90)	0.97 (0.94 - 1.00)
2012	0.85*** (0.82 - 0.88)	0.84*** (0.81 - 0.88)	0.96* (0.92 - 0.99)
2013	0.84*** (0.81 - 0.86)	0.85*** (0.82 - 0.89)	1.04* (1.01 - 1.08)
2014	0.87*** (0.83 - 0.91)	0.66*** (0.62 - 0.71)	1.21*** (1.15 - 1.27)
2015	0.90*** (0.86 - 0.95)	0.78*** (0.73 - 0.84)	1.15*** (1.09 - 1.21)
2016	0.83*** (0.79 - 0.87)	0.80*** (0.75 - 0.86)	1.23*** (1.17 - 1.30)
2017	0.80*** (0.76 - 0.84)	0.82*** (0.77 - 0.87)	1.22*** (1.16 - 1.29)
State			
Alaska	0.97 (0.59 - 1.58)	1.51 (0.81 - 2.83)	0.84 (0.54 - 1.32)
Arizona	0.46*** (0.29 - 0.73)	0.26*** (0.14 - 0.47)	0.12*** (0.08 - 0.19)
Arkansas	0.72 (0.44 - 1.17)	1.09 (0.58 - 2.05)	0.30*** (0.19 - 0.48)
Colorado	0.93 (0.59 - 1.46)	0.81 (0.44 - 1.49)	0.59* (0.39 - 0.91)

Connecticut	0.55** (0.35 - 0.86)	0.24*** (0.13 - 0.44)	0.27*** (0.18 - 0.41)
Delaware	1.54 (0.97 - 2.44)	0.17*** (0.09 - 0.32)	0.63* (0.41 - 0.96)
District of Columbia	3.23*** (1.97 - 5.28)	0.47* (0.23 - 0.97)	0.43** (0.26 - 0.73)
Florida	0.35*** (0.22 - 0.56)	1.4 (0.76 - 2.57)	0.53** (0.35 - 0.82)
Hawaii	0.65 (0.33 - 1.29)	0.8 (0.37 - 1.76)	1.1 (0.64 - 1.89)
Idaho	1.64 (0.97 - 2.78)	2.71** (1.41 - 5.22)	3.48*** (2.18 - 5.56)
Illinois	8.67*** (5.50 - 13.67)	0.66 (0.36 - 1.22)	1.23 (0.81 - 1.88)
Indiana	1.12 (0.71 - 1.77)	1.14 (0.62 - 2.09)	0.60* (0.39 - 0.92)
Iowa	1.14 (0.72 - 1.82)	0.56 (0.30 - 1.03)	0.58* (0.37 - 0.88)
Kansas	0.85 (0.50 - 1.44)	0.65 (0.33 - 1.31)	0.65 (0.40 - 1.05)
Kentucky	0.99 (0.63 - 1.56)	1.88* (1.03 - 3.43)	0.89 (0.58 - 1.36)
Louisiana	1.39 (0.86 - 2.24)	2.86*** (1.54 - 5.29)	0.7 (0.45 - 1.09)
Maine	1.21 (0.76 - 1.90)	0.38** (0.21 - 0.70)	0.42*** (0.27 - 0.64)
Maryland	0.58* (0.37 - 0.91)	0.48* (0.26 - 0.87)	0.68 (0.45 - 1.04)
Massachusetts	2.99*** (1.90 - 4.71)	0.49* (0.27 - 0.89)	1.25 (0.82 - 1.91)
Michigan	2.24*** (1.42 - 3.53)	0.86 (0.47 - 1.56)	0.56** (0.37 - 0.85)
Mississippi	0.71 (0.43 - 1.17)	0.41** (0.21 - 0.80)	0.32*** (0.20 - 0.50)
Missouri	0.29*** (0.19 - 0.47)	0.46* (0.25 - 0.84)	0.88 (0.58 - 1.35)
Montana	2.00** (1.24 - 3.23)	0.10*** (0.05 - 0.23)	1.39 (0.89 - 2.16)
Nebraska	1.25 (0.74 - 2.12)	1.11 (0.57 - 2.19)	0.44** (0.27 - 0.72)
Nevada	1.36 (0.60 - 3.06)	0.13 (0.02 - 1.07)	0.91 (0.41 - 2.01)
New Hampshire	1.42 (0.89 - 2.27)	0.26*** (0.13 - 0.49)	0.51** (0.33 - 0.79)
New Jersey	0.41*** (0.26 - 0.65)	0.98 (0.53 - 1.78)	0.93 (0.61 - 1.42)
New Mexico	1 (0.49 - 2.06)	0.71 (0.26 - 1.93)	0.34* (0.14 - 0.86)
New York	1.49	1.18	0.44***

	(0.94 - 2.34)	(0.65 - 2.15)	(0.29 - 0.67)
North Carolina	0.93	0.52*	0.19***
	(0.59 - 1.46)	(0.29 - 0.95)	(0.13 - 0.29)
North Dakota	2.34**	0.59	1.48
	(1.23 - 4.44)	(0.23 - 1.52)	(0.82 - 2.65)
Ohio	1.16	0.96	1.2
	(0.73 - 1.82)	(0.52 - 1.75)	(0.79 - 1.83)
Oklahoma	0.16***	1.06	0.75
	(0.09 - 0.30)	(0.56 - 2.00)	(0.48 - 1.18)
Pennsylvania	4.24***	2.12*	1.82**
	(2.66 - 6.76)	(1.14 - 3.93)	(1.18 - 2.82)
Rhode Island	0.67	0.13***	0.32***
	(0.42 - 1.06)	(0.07 - 0.25)	(0.21 - 0.49)
South Carolina	0.65	1.38	0.33***
	(0.41 - 1.04)	(0.75 - 2.54)	(0.21 - 0.51)
South Dakota	1.80*	0.72	1.77*
	(1.04 - 3.12)	(0.33 - 1.54)	(1.08 - 2.90)
Tennessee	1.38	0.35**	1.47
	(0.85 - 2.25)	(0.18 - 0.71)	(0.94 - 2.29)
Utah	1.4	1.73	1.74*
	(0.89 - 2.22)	(0.95 - 3.17)	(1.14 - 2.66)
Washington	0.94	2.49**	0.79
	(0.60 - 1.49)	(1.36 - 4.55)	(0.52 - 1.21)
Wyoming	0.97	0.68	0.38***
	(0.53 - 1.78)	(0.31 - 1.50)	(0.22 - 0.65)

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

Reference group for multinomial regression is self-referral. Adjusted Odds Ratio = AOR.
Confidence Interval = CI.

Table 4-A13. DID model for non-intensive outpatient treatment for OUD, many episodes

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	225,272	225,272	225,272
	RRR	RRR	RRR
	(95%CI)	(95%CI)	(95%CI)
Expansion	0.86 (0.55 - 1.33)	2.32** (1.30 - 4.16)	0.82 (0.54 - 1.24)
Post expansion	0.78*** (0.74 - 0.83)	0.79*** (0.73 - 0.85)	1.42*** (1.33 - 1.51)
Expansion * Post expansion	0.90*** (0.86 - 0.94)	1.36*** (1.28 - 1.44)	0.93** (0.88 - 0.97)
MAT (No= ref)			
Yes	0.54*** (0.53 - 0.55)	0.29*** (0.29 - 0.30)	0.13*** (0.13 - 0.14)
Frequency of use			
Some use	0.52*** (0.50 - 0.53)	0.57*** (0.56 - 0.59)	0.36*** (0.35 - 0.37)
Daily use	0.49*** (0.49 - 0.50)	0.39*** (0.38 - 0.39)	0.19*** (0.19 - 0.20)
Age (18-29= ref)			
30-44	0.94*** (0.92 - 0.96)	1.07*** (1.04 - 1.09)	0.91*** (0.89 - 0.93)
45-64	0.94*** (0.92 - 0.96)	0.96** (0.93 - 0.99)	0.68*** (0.67 - 0.70)
Gender			
Male	0.95*** (0.94 - 0.97)	0.75*** (0.73 - 0.76)	1.40*** (1.37 - 1.42)
Race/ethnicity			
Non-Hispanic Black	1.10*** (1.05 - 1.14)	1.04 (0.98 - 1.10)	0.86*** (0.81 - 0.90)
Hispanic	0.99 (0.95 - 1.03)	1.00 (0.95 - 1.05)	1.13*** (1.08 - 1.18)
Other	0.73*** (0.69 - 0.78)	0.75*** (0.70 - 0.81)	0.82*** (0.77 - 0.87)
Education			
Highschool or higher	1.00 (0.98 - 1.02)	0.81*** (0.79 - 0.83)	0.86*** (0.84 - 0.88)
Number of arrests (0=ref)			
1	0.79*** (0.76 - 0.82)	1.12*** (1.06 - 1.17)	2.35*** (2.27 - 2.43)
2 or more	0.68*** (0.62 - 0.74)	0.77*** (0.68 - 0.87)	1.34*** (1.24 - 1.44)
Employment status			
Employed	1.33*** (1.31 - 1.36)	1.27*** (1.24 - 1.31)	0.96*** (0.94 - 0.98)
Comorbidity			

Yes	1.21*** (1.19 - 1.23)	0.96*** (0.94 - 0.98)	0.76*** (0.75 - 0.78)
Homeless			
Yes	1.08*** (1.05 - 1.12)	1.42*** (1.37 - 1.47)	0.65*** (0.63 - 0.68)
Polysubstance use			
One more	1.00 (0.98 - 1.02)	1.11*** (1.08 - 1.14)	1.04*** (1.02 - 1.07)
Two or more	1.07*** (1.05 - 1.09)	1.24*** (1.21 - 1.27)	1.17*** (1.14 - 1.19)
Year			
2011	0.94*** (0.91 - 0.97)	0.86*** (0.83 - 0.90)	0.96* (0.93 - 1.00)
2012	0.85*** (0.82 - 0.87)	0.83*** (0.80 - 0.87)	0.95** (0.92 - 0.99)
2013	0.84*** (0.81 - 0.86)	0.84*** (0.80 - 0.87)	1.05** (1.02 - 1.09)
2014	1.12*** (1.07 - 1.17)	0.81*** (0.77 - 0.86)	0.88*** (0.84 - 0.93)
2015	1.14*** (1.11 - 1.18)	0.98 (0.94 - 1.02)	0.95** (0.92 - 0.98)
2016	1.04** (1.01 - 1.08)	1.00 (0.96 - 1.04)	1.01 (0.97 - 1.04)
State			
Arizona	0.51*** (0.46 - 0.55)	0.12*** (0.10 - 0.13)	0.16*** (0.15 - 0.18)
Arkansas	0.79* (0.65 - 0.95)	0.45*** (0.37 - 0.54)	0.39*** (0.32 - 0.47)
Colorado	0.98 (0.91 - 1.06)	0.35*** (0.32 - 0.38)	0.76*** (0.71 - 0.82)
Connecticut	0.59*** (0.55 - 0.64)	0.10*** (0.09 - 0.11)	0.34*** (0.32 - 0.37)
Delaware	1.68*** (1.52 - 1.85)	0.07*** (0.06 - 0.09)	0.80*** (0.73 - 0.88)
District of Columbia	3.95*** (3.24 - 4.82)	0.22*** (0.15 - 0.33)	0.58*** (0.43 - 0.80)
Florida	0.32*** (0.20 - 0.50)	1.32 (0.74 - 2.38)	0.55** (0.36 - 0.84)
Hawaii	0.65 (0.39 - 1.11)	0.33*** (0.20 - 0.55)	1.43* (1.01 - 2.02)
Idaho	1.51 (0.91 - 2.52)	2.63** (1.39 - 4.97)	3.59*** (2.26 - 5.69)
Illinois	10.06*** (9.43 - 10.73)	0.30*** (0.28 - 0.33)	1.64*** (1.53 - 1.75)
Indiana	1.25*** (1.13 - 1.39)	0.23*** (0.20 - 0.26)	0.74*** (0.67 - 0.81)
Kansas	0.78 (0.47 - 1.31)	0.64 (0.33 - 1.25)	0.67 (0.42 - 1.07)

Kentucky	1.07* (1.00 - 1.15)	0.76*** (0.72 - 0.80)	1.13*** (1.06 - 1.20)
Maine	1.11 (0.72 - 1.71)	0.36*** (0.20 - 0.64)	0.42*** (0.28 - 0.64)
Maryland	0.65*** (0.61 - 0.70)	0.21*** (0.19 - 0.22)	0.87*** (0.82 - 0.93)
Massachusetts	3.22*** (3.03 - 3.42)	0.20*** (0.18 - 0.22)	1.61*** (1.51 - 1.71)
Michigan	2.47*** (2.33 - 2.62)	0.35*** (0.33 - 0.37)	0.72*** (0.67 - 0.76)
Mississippi	0.66 (0.41 - 1.07)	0.40** (0.21 - 0.76)	0.32*** (0.21 - 0.50)
Missouri	0.28*** (0.18 - 0.44)	0.46** (0.25 - 0.82)	0.91 (0.60 - 1.38)
Montana	1.13 (0.67 - 1.88)	1.07 (0.56 - 2.07)	0.44*** (0.27 - 0.72)
Nebraska	1.52 (0.77 - 3.00)	0.06** (0.01 - 0.44)	1.21 (0.61 - 2.40)
New Hampshire	1.55*** (1.36 - 1.78)	0.11*** (0.08 - 0.14)	0.66*** (0.58 - 0.75)
New Jersey	0.45*** (0.42 - 0.49)	0.42*** (0.39 - 0.45)	1.20*** (1.13 - 1.28)
New Mexico	1.15 (0.61 - 2.17)	0.36* (0.15 - 0.86)	0.52 (0.21 - 1.27)
New York	1.60*** (1.52 - 1.69)	0.50*** (0.48 - 0.53)	0.57*** (0.54 - 0.60)
North Carolina	0.87 (0.56 - 1.34)	0.50* (0.28 - 0.90)	0.19*** (0.13 - 0.29)
North Dakota	2.43*** (1.54 - 3.84)	0.23*** (0.11 - 0.49)	1.83** (1.22 - 2.76)
Ohio	1.26*** (1.18 - 1.35)	0.39*** (0.37 - 0.42)	1.53*** (1.44 - 1.62)
Oklahoma	0.15*** (0.08 - 0.28)	0.99 (0.54 - 1.85)	0.75 (0.48 - 1.18)
Rhode Island	0.73*** (0.67 - 0.79)	0.06*** (0.05 - 0.07)	0.39*** (0.36 - 0.43)
South Carolina	0.61* (0.39 - 0.95)	1.32 (0.73 - 2.37)	0.34*** (0.22 - 0.52)
South Dakota	1.66 (0.97 - 2.82)	0.69 (0.33 - 1.45)	1.78* (1.09 - 2.90)
Tennessee	1.27 (0.80 - 2.03)	0.34** (0.17 - 0.67)	1.51 (0.98 - 2.34)
Utah	1.28 (0.83 - 1.98)	1.68 (0.93 - 3.01)	1.79** (1.18 - 2.71)
Wyoming	0.9 (0.50 - 1.62)	0.67 (0.31 - 1.45)	0.38*** (0.22 - 0.65)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A14. 2WFE model for the associations among non-MAT, non-intensive outpatient treatment for OUD, many episodes

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	169,449	169,449	169,449
	RRR (95%CI)	RRR (95%CI)	RRR (95%CI)
Medicaid expansion			
Expanded	0.89*** (0.85 - 0.94)	1.26*** (1.17 - 1.35)	0.86*** (0.82 - 0.91)
Frequency of use (No past month use= ref)			
Some use	0.58*** (0.57 - 0.60)	0.59*** (0.57 - 0.61)	0.38*** (0.37 - 0.39)
Daily use	0.70*** (0.68 - 0.71)	0.42*** (0.41 - 0.44)	0.23*** (0.22 - 0.23)
Age (18-29= ref)			
30-44	0.96*** (0.93 - 0.98)	1.11*** (1.08 - 1.14)	0.94*** (0.92 - 0.96)
45-64	1.00 (0.97 - 1.03)	0.94** (0.91 - 0.98)	0.76*** (0.74 - 0.78)
Gender (Female=ref)			
Male	0.98* (0.96 - 1.00)	0.71*** (0.70 - 0.73)	1.39*** (1.36 - 1.41)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.40*** (1.35 - 1.46)	1.48*** (1.41 - 1.56)	1.06** (1.02 - 1.10)
Hispanic	1.02 (0.99 - 1.06)	1.45*** (1.39 - 1.51)	1.25*** (1.20 - 1.29)
Other	0.83*** (0.79 - 0.88)	0.86*** (0.80 - 0.92)	0.87*** (0.83 - 0.92)
Education (Less than high school= ref)			
Highschool or higher	0.96*** (0.94 - 0.98)	0.78*** (0.76 - 0.80)	0.82*** (0.80 - 0.83)
Number of arrests (0= ref)			
1	0.72*** (0.69 - 0.76)	1.07* (1.02 - 1.13)	1.96*** (1.89 - 2.04)

2 or more	0.59*** (0.53 - 0.65)	0.69*** (0.61 - 0.79)	1.12** (1.03 - 1.22)
Employment status (Not employed= ref)			
Employed	1.38*** (1.35 - 1.42)	1.24*** (1.21 - 1.28)	0.95*** (0.93 - 0.97)
Comorbidity (No= ref)			
Yes	1.20*** (1.18 - 1.23)	0.85*** (0.83 - 0.88)	0.70*** (0.68 - 0.71)
Homeless (No= ref)			
Yes	1.10*** (1.05 - 1.14)	1.43*** (1.37 - 1.50)	0.61*** (0.58 - 0.64)
Polysubstance use (no= ref)			
One more	0.92*** (0.89 - 0.94)	1.02 (0.99 - 1.05)	0.96*** (0.94 - 0.98)
Two or more	0.94*** (0.91 - 0.96)	1.09*** (1.06 - 1.12)	1.03** (1.01 - 1.06)
Year			
2011	0.93*** (0.90 - 0.97)	0.88*** (0.84 - 0.93)	0.98 (0.95 - 1.02)
2012	0.85*** (0.81 - 0.88)	0.86*** (0.83 - 0.91)	0.97 (0.93 - 1.01)
2013	0.82*** (0.79 - 0.86)	0.88*** (0.84 - 0.92)	1.06** (1.02 - 1.10)
2014	0.85*** (0.80 - 0.91)	0.69*** (0.64 - 0.75)	1.32*** (1.24 - 1.39)
2015	0.82*** (0.78 - 0.88)	0.76*** (0.70 - 0.82)	1.13*** (1.07 - 1.20)
2016	0.79*** (0.74 - 0.83)	0.75*** (0.70 - 0.81)	1.19*** (1.12 - 1.26)
2017	0.78***	0.74***	1.13***
State			
Alaska	0.42* (0.18 - 0.95)	1.05 (0.40 - 2.73)	0.62 (0.31 - 1.25)
Arizona	0.17*** (0.08 - 0.38)	0.13*** (0.05 - 0.34)	0.08*** (0.04 - 0.15)
Arkansas	0.29** (0.13 - 0.65)	0.71 (0.27 - 1.85)	0.18*** (0.09 - 0.36)
Colorado	0.33** (0.15 - 0.73)	0.59 (0.23 - 1.51)	0.44* (0.22 - 0.87)
Connecticut	0.37*	0.31*	0.29***

	(0.17 - 0.82)	(0.12 - 0.81)	(0.15 - 0.58)
Delaware	0.73	0.10***	0.47*
	(0.33 - 1.62)	(0.04 - 0.26)	(0.24 - 0.93)
District of Columbia	0.79	0.23**	0.20***
	(0.35 - 1.78)	(0.08 - 0.65)	(0.09 - 0.42)
Florida	0.27**	1.45	0.52
	(0.12 - 0.60)	(0.56 - 3.73)	(0.26 - 1.04)
Hawaii	0.34*	0.53	0.82
	(0.13 - 0.89)	(0.18 - 1.58)	(0.38 - 1.79)
Idaho	0.71	1.59	2.18*
	(0.31 - 1.64)	(0.60 - 4.24)	(1.07 - 4.44)
Illinois	2.69*	0.33*	0.66
	(1.22 - 5.92)	(0.13 - 0.85)	(0.33 - 1.30)
Indiana	0.53	0.8	0.45*
	(0.24 - 1.17)	(0.31 - 2.05)	(0.23 - 0.89)
Iowa	0.41*	0.35*	0.37**
	(0.19 - 0.91)	(0.13 - 0.89)	(0.19 - 0.74)
Kansas	0.34*	0.4	0.42*
	(0.15 - 0.80)	(0.15 - 1.08)	(0.20 - 0.86)
Kentucky	0.34**	0.96	0.49*
	(0.16 - 0.76)	(0.37 - 2.45)	(0.25 - 0.96)
Louisiana	0.59	1.4	0.40*
	(0.26 - 1.32)	(0.54 - 3.63)	(0.20 - 0.81)
Maine	0.34**	0.22**	0.28***
	(0.15 - 0.76)	(0.09 - 0.58)	(0.14 - 0.56)
Maryland	0.32**	0.38*	0.55
	(0.14 - 0.69)	(0.15 - 0.97)	(0.28 - 1.08)
Massachusetts	1.05	0.28**	0.86
	(0.47 - 2.30)	(0.11 - 0.73)	(0.43 - 1.70)
Michigan	0.79	0.36*	0.34**
	(0.36 - 1.75)	(0.14 - 0.93)	(0.17 - 0.68)
Mississippi	0.30**	0.26**	0.21***
	(0.13 - 0.67)	(0.10 - 0.69)	(0.10 - 0.42)
Missouri	0.11***	0.20***	0.51
	(0.05 - 0.24)	(0.08 - 0.51)	(0.26 - 1.02)
Montana	0.91	0.06***	0.91
	(0.41 - 2.02)	(0.02 - 0.18)	(0.45 - 1.82)
Nebraska	0.53	0.55	0.24***
	(0.23 - 1.24)	(0.20 - 1.48)	(0.11 - 0.49)
Nevada	0.28	0.17	0.81
	(0.05 - 1.65)	(0.02 - 1.66)	(0.26 - 2.56)
New Hampshire	0.57	0.14***	0.34**

	(0.25 - 1.26)	(0.05 - 0.38)	(0.17 - 0.67)
New Jersey	0.34**	0.91	1.16
	(0.15 - 0.74)	(0.35 - 2.33)	(0.58 - 2.29)
New Mexico	0	0.47	0.29
	(0.00 - .)	(0.09 - 2.48)	(0.08 - 1.03)
New York	0.7	0.79	0.28***
	(0.32 - 1.54)	(0.31 - 2.02)	(0.14 - 0.55)
North Carolina	0.37*	0.29*	0.12***
	(0.17 - 0.81)	(0.11 - 0.75)	(0.06 - 0.23)
North Dakota	1.07	0.37	1
	(0.43 - 2.66)	(0.11 - 1.23)	(0.45 - 2.21)
Ohio	0.33**	0.51	0.63
	(0.15 - 0.73)	(0.20 - 1.32)	(0.32 - 1.26)
Oklahoma	0.08***	0.68	0.51
	(0.03 - 0.18)	(0.26 - 1.78)	(0.25 - 1.02)
Pennsylvania	2.17	0.69	1.24
	(0.97 - 4.85)	(0.26 - 1.82)	(0.62 - 2.48)
Rhode Island	0.79	0.24**	0.41*
	(0.35 - 1.74)	(0.09 - 0.62)	(0.20 - 0.81)
South Carolina	0.27**	0.73	0.19***
	(0.12 - 0.59)	(0.28 - 1.88)	(0.10 - 0.38)
South Dakota	0.86	0.4	1.04
	(0.37 - 2.01)	(0.14 - 1.15)	(0.50 - 2.15)
Tennessee	0.57	0.21**	0.91
	(0.25 - 1.28)	(0.08 - 0.58)	(0.45 - 1.82)
Utah	0.57	0.99	1.2
	(0.26 - 1.26)	(0.39 - 2.56)	(0.61 - 2.38)
Washington	0.45*	1.44	0.6
	(0.20 - 1.00)	(0.56 - 3.70)	(0.30 - 1.18)
Wyoming	0.42	0.45	0.25***
	(0.17 - 1.04)	(0.16 - 1.32)	(0.12 - 0.54)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR.

Confidence Interval = CI.

Table 4-A15. 2WFE model for the associations among MAT, non-intensive outpatient treatment for OUD with many treatment episodes: logit models

	Healthcare provider referral	Other institutional referral	Court/criminal justice referral
N	166,400	141,859	141,885
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expanded	0.88** (0.81 - 0.95)	1.59*** (1.38 - 1.82)	1.15* (1.01 - 1.32)
Frequency of use (No past month use= ref)			
Some use	0.42*** (0.41 - 0.44)	0.61*** (0.58 - 0.65)	0.39*** (0.37 - 0.41)
Daily use	0.32*** (0.31 - 0.33)	0.41*** (0.39 - 0.43)	0.19*** (0.18 - 0.20)
Age (18-29= ref)			
30-44	0.91*** (0.88 - 0.94)	0.91*** (0.87 - 0.96)	0.74*** (0.70 - 0.77)
45-64	0.81*** (0.78 - 0.84)	0.75*** (0.71 - 0.80)	0.44*** (0.42 - 0.47)
Gender (Female=ref)			
Male	0.93*** (0.90 - 0.95)	0.81*** (0.78 - 0.85)	1.45*** (1.39 - 1.51)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.95* (0.91 - 1.00)	1.18*** (1.11 - 1.26)	0.99 (0.92 - 1.07)
Hispanic	0.83*** (0.79 - 0.86)	1.05 (0.99 - 1.12)	0.83*** (0.77 - 0.88)
Other	0.74*** (0.68 - 0.79)	0.83*** (0.75 - 0.92)	0.95 (0.84 - 1.07)
Education (Less than high school= ref)			
Highschool or higher	1.03* (1.00 - 1.06)	0.91*** (0.87 - 0.95)	1.01 (0.97 - 1.06)
Number of arrests (0= ref)			
1	0.88*** (0.82 - 0.94)	1.05 (0.95 - 1.15)	4.31*** (4.04 - 4.59)

2 or more	0.85 (0.71 - 1.00)	0.91 (0.72 - 1.16)	2.64*** (2.20 - 3.17)
Employment status (Not employed= ref)			
Employed	1.25*** (1.21 - 1.29)	1.29*** (1.23 - 1.36)	0.99 (0.94 - 1.04)
Comorbidity (No= ref)			
Yes	1.15*** (1.12 - 1.18)	1.23*** (1.18 - 1.28)	1.01 (0.97 - 1.05)
Homeless (No= ref)			
Yes	1.05* (1.00 - 1.10)	1.32*** (1.24 - 1.41)	0.82*** (0.76 - 0.90)
Polysubstance use (no= ref)			
One more	1.10*** (1.06 - 1.13)	1.25*** (1.19 - 1.31)	1.29*** (1.23 - 1.35)
Two or more	1.27*** (1.23 - 1.31)	1.45*** (1.37 - 1.52)	1.61*** (1.52 - 1.69)
Year			
2011	0.98 (0.93 - 1.04)	0.82*** (0.74 - 0.90)	0.85** (0.77 - 0.95)
2012	0.91*** (0.86 - 0.96)	0.76*** (0.70 - 0.84)	0.86** (0.77 - 0.95)
2013	0.91** (0.86 - 0.96)	0.77*** (0.70 - 0.85)	0.97 (0.88 - 1.07)
2014	0.97 (0.89 - 1.07)	0.56*** (0.48 - 0.66)	0.98 (0.84 - 1.14)
2015	1.08 (0.99 - 1.18)	0.76*** (0.65 - 0.88)	1.14 (0.98 - 1.32)
2016	0.93 (0.85 - 1.02)	0.81** (0.70 - 0.94)	1.25** (1.08 - 1.45)
2017	0.86** (0.79 - 0.94)	0.79** (0.68 - 0.91)	1.39*** (1.20 - 1.61)
State			
Alaska	1.7 (0.81 - 3.55)	1.04 (0.39 - 2.75)	0.36* (0.14 - 0.90)
Arizona	0.94 (0.49 - 1.80)	0.6 (0.25 - 1.43)	0.24*** (0.12 - 0.49)
Arkansas	1.2 (0.60 - 2.39)	0.85 (0.33 - 2.14)	0.51 (0.24 - 1.08)
Colorado	1.76 (0.93 - 3.30)	0.58 (0.25 - 1.38)	0.42* (0.22 - 0.82)
Connecticut	0.66	0.09***	0.11***

	(0.35 - 1.25)	(0.04 - 0.20)	(0.05 - 0.21)
Delaware	2.02*	0.25**	0.40**
	(1.06 - 3.83)	(0.10 - 0.65)	(0.20 - 0.80)
District of Columbia	16.07***	0.25	1.29
	(7.69 - 33.60)	(0.03 - 2.18)	(0.42 - 3.94)
Florida	0.29***	0.44	0.21***
	(0.15 - 0.56)	(0.18 - 1.07)	(0.10 - 0.42)
Hawaii	0.33	0.84	0.32
	(0.04 - 2.72)	(0.16 - 4.48)	(0.04 - 2.67)
Idaho	2.3	5.61**	5.58***
	(0.80 - 6.66)	(1.77 - 17.80)	(2.18 - 14.28)
Illinois	23.88***	0.82	0.95
	(12.70 - 44.91)	(0.34 - 1.96)	(0.48 - 1.85)
Indiana	1.07	0.74	0.40**
	(0.55 - 2.08)	(0.30 - 1.81)	(0.20 - 0.80)
Iowa	5.21***	0.39	0.8
	(2.69 - 10.08)	(0.14 - 1.08)	(0.38 - 1.69)
Kentucky	2.30**	3.21**	1.67
	(1.23 - 4.33)	(1.37 - 7.51)	(0.87 - 3.22)
Louisiana	0.83	16.71***	2.83*
	(0.24 - 2.86)	(6.43 - 43.39)	(1.11 - 7.21)
Maine	1.83	0.43*	0.37**
	(0.98 - 3.44)	(0.18 - 1.00)	(0.19 - 0.71)
Maryland	0.74	0.36*	0.42**
	(0.39 - 1.38)	(0.15 - 0.83)	(0.22 - 0.80)
Massachusetts	5.61***	0.46	0.47*
	(2.99 - 10.52)	(0.20 - 1.08)	(0.24 - 0.91)
Michigan	4.17***	1.33	0.33***
	(2.22 - 7.81)	(0.57 - 3.12)	(0.17 - 0.63)
Mississippi	1.08		0.25
	(0.27 - 4.38)		(0.03 - 2.19)
Missouri	0.65	1.02	1.27
	(0.34 - 1.24)	(0.44 - 2.41)	(0.66 - 2.44)
Nebraska	1.68	4.04*	1.76
	(0.60 - 4.75)	(1.30 - 12.60)	(0.65 - 4.81)
Nevada	2.61		0.32
	(0.98 - 6.96)		(0.08 - 1.38)
New Hampshire	3.40***	0.63	0.95
	(1.70 - 6.80)	(0.22 - 1.75)	(0.44 - 2.05)
New Jersey	0.62	0.97	0.39**
	(0.33 - 1.16)	(0.41 - 2.27)	(0.20 - 0.75)
New Mexico	2.17	0.71	0.15
	(0.93 - 5.09)	(0.19 - 2.70)	(0.02 - 1.23)
New York	2.03*	0.95	0.63

	(1.09 - 3.81)	(0.41 - 2.23)	(0.33 - 1.21)
North Carolina	1.26	0.91	0.23***
	(0.67 - 2.36)	(0.39 - 2.13)	(0.12 - 0.45)
North Dakota	3.16***	0.99	1.77
	(1.68 - 5.93)	(0.42 - 2.32)	(0.92 - 3.40)
Pennsylvania	4.89***	4.20**	1.38
	(2.55 - 9.36)	(1.76 - 9.98)	(0.69 - 2.75)
Rhode Island	0.76	0.06***	0.18***
	(0.40 - 1.42)	(0.03 - 0.15)	(0.09 - 0.36)
South Carolina	1.4	3.86**	0.77
	(0.69 - 2.85)	(1.59 - 9.38)	(0.37 - 1.60)
South Dakota	1.9	2.48	7.25***
	(0.49 - 7.37)	(0.51 - 12.03)	(2.54 - 20.72)
Tennessee	3.66		30.54***
	(0.52 - 25.60)		(6.67 - 139.79)
Utah	2.40**	2.14	0.78
	(1.27 - 4.53)	(0.91 - 5.03)	(0.40 - 1.52)
Washington	1.29	2.71*	0.41**
	(0.68 - 2.42)	(1.16 - 6.34)	(0.21 - 0.79)
Wyoming	2.46		0.33
	(0.61 - 9.98)		(0.04 - 3.17)

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

Reference group for logistic regression is self-referral. Adjusted Odds Ratio = AOR. Confidence Interval = CI.

Table 4-A16. DID model for the associations among non-MAT, non-intensive outpatient treatment for OUD

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	313,253	313,253	313,253
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion	0.45* (0.20 - 0.99)	1.39 (0.54 - 3.56)	0.61 (0.31 - 1.21)
Post expansion	0.77*** (0.72 - 0.81)	0.70*** (0.65 - 0.76)	1.15*** (1.09 - 1.22)
Expansion * Post expansion	0.87*** (0.83 - 0.92)	1.29*** (1.20 - 1.38)	0.82*** (0.78 - 0.86)
Frequency of use (No past month use= ref)			
Some use	0.58*** (0.56 - 0.60)	0.59*** (0.57 - 0.61)	0.37*** (0.36 - 0.38)
Daily use	0.70*** (0.69 - 0.72)	0.43*** (0.42 - 0.44)	0.22*** (0.22 - 0.23)
Age (18-29= ref)			
30-44	0.96*** (0.94 - 0.98)	1.12*** (1.09 - 1.15)	0.95*** (0.93 - 0.97)
45-64	0.99 (0.96 - 1.02)	0.97 (0.93 - 1.00)	0.76*** (0.74 - 0.78)
Gender (Female=ref)			
Male	0.98 (0.96 - 1.00)	0.72*** (0.70 - 0.74)	1.38*** (1.35 - 1.41)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	1.43*** (1.37 - 1.48)	1.47*** (1.40 - 1.55)	1.06** (1.02 - 1.10)
Hispanic	1.03 (0.99 - 1.07)	1.45*** (1.39 - 1.51)	1.25*** (1.21 - 1.29)
Other	0.86*** (0.81 - 0.91)	0.86*** (0.80 - 0.92)	0.89*** (0.84 - 0.94)
Education (Less than high school= ref)			
Highschool or higher	0.96*** (0.93 - 0.98)	0.78*** (0.76 - 0.81)	0.82*** (0.80 - 0.84)
Number of arrests (0= ref)			

1	0.72*** (0.68 - 0.76)	1.08** (1.02 - 1.14)	1.95*** (1.87 - 2.02)
2 or more	0.60*** (0.54 - 0.67)	0.68*** (0.59 - 0.78)	1.11* (1.02 - 1.20)
Employment status (Not employed= ref)			
Employed	1.40*** (1.37 - 1.44)	1.26*** (1.22 - 1.30)	0.96*** (0.94 - 0.99)
Comorbidity (No= ref)			
Yes	1.21*** (1.18 - 1.24)	0.86*** (0.84 - 0.88)	0.70*** (0.68 - 0.71)
Homeless (No= ref)			
Yes	1.10*** (1.06 - 1.15)	1.43*** (1.36 - 1.50)	0.61*** (0.58 - 0.64)
Polysubstance use (no= ref)			
One more	0.91*** (0.89 - 0.94)	1.01 (0.98 - 1.04)	0.94*** (0.92 - 0.96)
Two or more	0.94*** (0.92 - 0.97)	1.08*** (1.05 - 1.12)	1.01 (0.99 - 1.04)
Year			
2011	0.94*** (0.90 - 0.97)	0.89*** (0.85 - 0.94)	0.98 (0.94 - 1.02)
2012	0.85*** (0.82 - 0.88)	0.87*** (0.83 - 0.91)	0.97 (0.93 - 1.01)
2013	0.82*** (0.79 - 0.85)	0.86*** (0.82 - 0.91)	1.06** (1.02 - 1.11)
2014	1.13*** (1.09 - 1.18)	0.94* (0.90 - 0.99)	1.20*** (1.16 - 1.25)
2015	1.09*** (1.04 - 1.14)	1.04 (0.99 - 1.09)	1.03 (0.99 - 1.07)
2016	1.03 (0.99 - 1.08)	1.03 (0.98 - 1.08)	1.07*** (1.03 - 1.11)
State			
Arizona	0.39*** (0.34 - 0.43)	0.09*** (0.08 - 0.11)	0.13*** (0.12 - 0.14)
Arkansas	0.64*** (0.50 - 0.82)	0.49*** (0.39 - 0.61)	0.30*** (0.24 - 0.37)
Colorado	0.75*** (0.66 - 0.84)	0.41*** (0.37 - 0.46)	0.74*** (0.68 - 0.81)
Connecticut	0.85** (0.75 - 0.95)	0.22*** (0.20 - 0.25)	0.50*** (0.45 - 0.55)

Delaware	1.63*** (1.43 - 1.87)	0.07*** (0.05 - 0.09)	0.80*** (0.72 - 0.89)
District of Columbia	1.75*** (1.38 - 2.21)	0.16*** (0.11 - 0.24)	0.33*** (0.24 - 0.46)
Florida	0.27** (0.12 - 0.59)	1.39 (0.54 - 3.59)	0.53 (0.27 - 1.06)
Hawaii	0.76 (0.44 - 1.32)	0.37*** (0.21 - 0.64)	1.38 (0.95 - 2.00)
Idaho	0.7 (0.30 - 1.62)	1.56 (0.59 - 4.15)	2.18* (1.07 - 4.45)
Illinois	5.99*** (5.45 - 6.59)	0.23*** (0.20 - 0.25)	1.11* (1.02 - 1.21)
Indiana	0.92 (0.81 - 1.05)	0.24*** (0.21 - 0.28)	0.63*** (0.56 - 0.70)
Kansas	0.34* (0.15 - 0.79)	0.39 (0.14 - 1.06)	0.42* (0.21 - 0.86)
Kentucky	0.77*** (0.70 - 0.85)	0.66*** (0.61 - 0.72)	0.82*** (0.76 - 0.88)
Maine	0.34** (0.15 - 0.75)	0.22** (0.08 - 0.57)	0.29*** (0.14 - 0.57)
Maryland	0.70*** (0.63 - 0.77)	0.26*** (0.24 - 0.29)	0.91* (0.84 - 0.99)
Massachusetts	2.32*** (2.11 - 2.55)	0.20*** (0.18 - 0.22)	1.45*** (1.34 - 1.57)
Michigan	1.77*** (1.62 - 1.94)	0.25*** (0.23 - 0.28)	0.58*** (0.54 - 0.62)
Mississippi	0.30** (0.13 - 0.67)	0.26** (0.10 - 0.69)	0.21*** (0.10 - 0.42)
Missouri	0.11*** (0.05 - 0.24)	0.20*** (0.08 - 0.50)	0.52 (0.26 - 1.02)
Montana	0.53 (0.23 - 1.23)	0.54 (0.20 - 1.45)	0.24*** (0.11 - 0.50)
Nebraska	0.64 (0.13 - 3.11)	0.12* (0.01 - 0.96)	1.38 (0.55 - 3.51)
New Hampshire	1.27** (1.09 - 1.49)	0.10*** (0.08 - 0.13)	0.57*** (0.50 - 0.66)
New Jersey	0.76*** (0.67 - 0.86)	0.63*** (0.57 - 0.71)	1.95*** (1.79 - 2.13)
New Mexico	0 (0.00 - .)	0.33 (0.08 - 1.29)	0.48 (0.16 - 1.43)
New York	1.56*** (1.44 - 1.70)	0.55*** (0.51 - 0.59)	0.47*** (0.44 - 0.50)

North Carolina	0.36* (0.17 - 0.80)	0.28** (0.11 - 0.73)	0.12*** (0.06 - 0.23)
North Dakota	2.38*** (1.50 - 3.77)	0.26*** (0.12 - 0.54)	1.67* (1.11 - 2.51)
Ohio	0.74*** (0.67 - 0.82)	0.36*** (0.33 - 0.39)	1.07 (0.99 - 1.15)
Oklahoma	0.07*** (0.03 - 0.18)	0.65 (0.25 - 1.71)	0.51 (0.25 - 1.03)
Rhode Island	1.77*** (1.53 - 2.05)	0.16*** (0.13 - 0.21)	0.68*** (0.60 - 0.78)
South Carolina	0.27** (0.12 - 0.59)	0.71 (0.28 - 1.83)	0.19*** (0.10 - 0.38)
South Dakota	0.85 (0.36 - 2.00)	0.39 (0.14 - 1.14)	1.04 (0.50 - 2.16)
Tennessee	0.56 (0.25 - 1.26)	0.21** (0.08 - 0.56)	0.91 (0.45 - 1.83)
Utah	0.56 (0.26 - 1.25)	0.97 (0.38 - 2.49)	1.21 (0.61 - 2.39)
Wyoming	0.43 (0.17 - 1.04)	0.45 (0.16 - 1.32)	0.25*** (0.12 - 0.54)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

Table 4-A17. DID model for the associations among MAT, non-intensive outpatient treatment for OUD with many treatment episodes

	Healthcare provider referral	Other institutional Referral	Court/criminal justice referral
N	60,852	60,852	60,852
	RRR	RRR	RRR
	(95%CI)	(95%CI)	(95%CI)
Expansion	1.28	2.68*	0.40**
	(0.68 - 2.41)	(1.15 - 6.28)	(0.21 - 0.78)
Post expansion	0.86***	0.77***	1.37***
	(0.79 - 0.94)	(0.66 - 0.89)	(1.18 - 1.59)
Expansion * Post expansion	0.89**	1.61***	1.17*
	(0.82 - 0.96)	(1.40 - 1.85)	(1.02 - 1.35)
Frequency of use (No past month use= ref)			
Some use	0.42***	0.62***	0.39***
	(0.40 - 0.44)	(0.58 - 0.65)	(0.37 - 0.41)
Daily use	0.31***	0.41***	0.19***
	(0.30 - 0.32)	(0.39 - 0.43)	(0.18 - 0.20)
Age (18-29= ref)			
30-44	0.91***	0.91***	0.74***
	(0.88 - 0.94)	(0.87 - 0.95)	(0.71 - 0.78)
45-64	0.81***	0.75***	0.44***
	(0.78 - 0.84)	(0.71 - 0.80)	(0.42 - 0.47)
Gender (Female=ref)			
Male	0.92***	0.81***	1.45***
	(0.90 - 0.95)	(0.78 - 0.84)	(1.39 - 1.51)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96	1.18***	0.99
	(0.91 - 1.00)	(1.11 - 1.26)	(0.92 - 1.07)
Hispanic	0.83***	1.06	0.82***
	(0.79 - 0.86)	(0.99 - 1.12)	(0.77 - 0.88)
Other	0.74***	0.82***	0.96
	(0.68 - 0.79)	(0.74 - 0.91)	(0.85 - 1.07)
Education (Less than high school= ref)			
Highschool or higher	1.03*	0.91***	1.02
	(1.00 - 1.06)	(0.87 - 0.95)	(0.97 - 1.06)
Number of arrests (0= ref)			

1	0.88*** (0.82 - 0.94)	1.05 (0.95 - 1.16)	4.29*** (4.02 - 4.58)
2 or more	0.84 (0.71 - 1.00)	0.94 (0.74 - 1.19)	2.67*** (2.22 - 3.21)
Employment status (Not employed= ref)			
Employed	1.25*** (1.21 - 1.30)	1.30*** (1.23 - 1.37)	0.99 (0.95 - 1.04)
Comorbidity (No= ref)			
Yes	1.14*** (1.11 - 1.18)	1.22*** (1.17 - 1.27)	1.00 (0.96 - 1.04)
Homeless (No= ref)			
Yes	1.05* (1.00 - 1.10)	1.33*** (1.24 - 1.42)	0.82*** (0.76 - 0.90)
Polysubstance use (no= ref)			
One more	1.09*** (1.06 - 1.12)	1.25*** (1.19 - 1.31)	1.28*** (1.22 - 1.35)
Two or more	1.27*** (1.23 - 1.31)	1.45*** (1.38 - 1.53)	1.61*** (1.52 - 1.69)
Year			
2011	0.98 (0.93 - 1.04)	0.81*** (0.74 - 0.89)	0.85** (0.77 - 0.95)
2012	0.91*** (0.86 - 0.96)	0.75*** (0.69 - 0.83)	0.86** (0.77 - 0.95)
2013	0.91** (0.86 - 0.97)	0.77*** (0.70 - 0.85)	0.98 (0.89 - 1.08)
2014	1.12*** (1.07 - 1.18)	0.72*** (0.66 - 0.77)	0.70*** (0.64 - 0.75)
2015	1.24*** (1.19 - 1.30)	0.97 (0.90 - 1.03)	0.82*** (0.76 - 0.88)
2016	1.07** (1.02 - 1.12)	1.03 (0.97 - 1.10)	0.89*** (0.84 - 0.95)
State			
Arizona	0.73*** (0.62 - 0.87)	0.22*** (0.18 - 0.27)	0.60*** (0.46 - 0.78)
Arkansas	0.93 (0.69 - 1.25)	0.31*** (0.21 - 0.46)	1.25 (0.84 - 1.86)
Colorado	1.37*** (1.23 - 1.52)	0.22*** (0.18 - 0.25)	1.04 (0.87 - 1.24)
Connecticut	0.52*** (0.47 - 0.57)	0.03*** (0.03 - 0.04)	0.26*** (0.22 - 0.31)
Delaware	1.57***	0.09***	0.98

	(1.35 - 1.82)	(0.06 - 0.14)	(0.75 - 1.28)
District of Columbia	12.48***	0.09*	3.17*
	(8.41 - 18.52)	(0.01 - 0.68)	(1.27 - 7.91)
Florida	0.29***	0.44	0.21***
	(0.15 - 0.57)	(0.18 - 1.06)	(0.10 - 0.42)
Hawaii	0.26	0.31	0.79
	(0.03 - 1.93)	(0.07 - 1.32)	(0.10 - 5.91)
Idaho	2.3	5.60**	5.55***
	(0.80 - 6.66)	(1.77 - 17.75)	(2.17 - 14.22)
Illinois	18.53***	0.30***	2.32***
	(16.73 - 20.53)	(0.25 - 0.37)	(1.89 - 2.85)
Kansas	4.06***	0.14***	1.97***
	(3.26 - 5.06)	(0.08 - 0.26)	(1.34 - 2.89)
Kentucky	1.79***	1.19***	4.13***
	(1.61 - 1.98)	(1.08 - 1.31)	(3.59 - 4.75)
Maine	1.84	0.43*	0.37**
	(0.98 - 3.44)	(0.18 - 1.00)	(0.19 - 0.71)
Maryland	0.57***	0.13***	1.02
	(0.52 - 0.63)	(0.12 - 0.15)	(0.89 - 1.18)
Massachusetts	4.38***	0.17***	1.15
	(4.02 - 4.76)	(0.15 - 0.20)	(0.98 - 1.36)
Michigan	3.24***	0.49***	0.81**
	(2.99 - 3.52)	(0.45 - 0.54)	(0.70 - 0.93)
Mississippi	1.09		0.25
	(0.27 - 4.42)		(0.03 - 2.21)
Missouri	0.66	1.03	1.27
	(0.34 - 1.25)	(0.44 - 2.41)	(0.66 - 2.45)
Montana	1.68	4.03*	1.76
	(0.59 - 4.74)	(1.29 - 12.54)	(0.64 - 4.79)
Nebraska	2.03		0.79
	(0.95 - 4.33)		(0.21 - 2.92)
New Hampshire	2.64***	0.23***	2.34***
	(1.95 - 3.59)	(0.13 - 0.42)	(1.53 - 3.59)
New Jersey	0.48***	0.36***	0.96
	(0.44 - 0.53)	(0.33 - 0.39)	(0.84 - 1.11)
New Mexico	1.69	0.26*	0.37
	(0.95 - 3.02)	(0.09 - 0.73)	(0.05 - 2.73)
New York	1.58***	0.35***	1.56***
	(1.47 - 1.71)	(0.33 - 0.38)	(1.38 - 1.76)
North Carolina	1.26	0.92	0.23***
	(0.67 - 2.36)	(0.39 - 2.14)	(0.12 - 0.45)
Ohio	2.46***	0.36***	4.34***

	(2.24 - 2.69)	(0.32 - 0.41)	(3.80 - 4.96)
Oklahoma	0.59***	0.02***	0.45***
	(0.53 - 0.65)	(0.02 - 0.03)	(0.38 - 0.54)
South Carolina	1.41	3.87**	0.78
	(0.69 - 2.86)	(1.59 - 9.40)	(0.38 - 1.61)
South Dakota	1.9	2.48	7.28***
	(0.49 - 7.37)	(0.51 - 12.02)	(2.55 - 20.77)
Tennessee	3.67		30.76***
	(0.53 - 25.70)		(6.72 - 140.78)
Utah	2.41**	2.14	0.78
	(1.28 - 4.56)	(0.91 - 5.04)	(0.40 - 1.53)
Wyoming	2.46		0.34
	(0.60 - 9.97)		(0.04 - 3.20)

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

Reference group for multinomial regression is self-referral. Relative Risk Ratio = RRR. Confidence Interval = CI.

FULL TABLES

Appendix 4-B

Full tables from Chapter 4 (with details for state and year fixed effects)

Table 4-B1. 2WFE model for the adjusted associations between Medicaid expansion and length of stay

	2 ways fixed effect pooled model	2 ways fixed effect non-MAT	2 ways fixed effect MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.93*** (0.89 - 0.97)	0.92** (0.88 - 0.97)	1.19*** (1.08 - 1.30)
MAT (No= ref)			
Yes	2.22*** (2.16 - 2.27)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.04)	0.87*** (0.83 - 0.92)
Institutional referral	1.04* (1.01 - 1.08)	1.21*** (1.17 - 1.26)	0.78*** (0.72 - 0.84)
Court/criminal justice	1.87*** (1.82 - 1.92)	2.14*** (2.07 - 2.20)	0.74*** (0.69 - 0.81)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.70 - 0.74)	0.70*** (0.68 - 0.73)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.80 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.04 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.31*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.31*** (1.25 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.91)	0.89*** (0.87 - 0.91)	0.92*** (0.89 - 0.95)

Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94** (0.89 - 0.98)	0.93* (0.87 - 0.98)
Hispanic	1.01 (0.98 - 1.05)	0.94* (0.90 - 0.99)	1.09** (1.03 - 1.16)
Other	1.00 (0.95 - 1.06)	1.00 (0.94 - 1.06)	0.99 (0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.97 (0.93 - 1.01)	1.04 (0.99 - 1.09)	0.79*** (0.73 - 0.86)
2 or more	1.18*** (1.09 - 1.28)	1.17*** (1.07 - 1.27)	0.88 (0.73 - 1.06)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.90*** (0.87 - 0.92)	0.89*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.74*** (0.70 - 0.77)	0.77*** (0.73 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.80*** (0.78 - 0.81)	0.80*** (0.78 - 0.82)	0.86*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.74)	0.76*** (0.73 - 0.78)	0.76*** (0.72 - 0.80)
Year			
2011	1.16*** (1.12 - 1.21)	1.21*** (1.16 - 1.27)	1.08* (1.00 - 1.16)
2012	1.14*** (1.10 - 1.19)	1.21*** (1.16 - 1.27)	1.06 (0.98 - 1.15)
2013	1.18*** (1.13 - 1.23)	1.26*** (1.20 - 1.31)	1.06 (0.98 - 1.15)
2014	1.48*** (1.41 - 1.55)	1.68*** (1.59 - 1.77)	0.90* (0.80 - 1.00)

2015	1.15*** (1.09 - 1.21)	1.36*** (1.28 - 1.44)	0.69*** (0.62 - 0.76)
2016	1.19*** (1.13 - 1.25)	1.41*** (1.33 - 1.49)	0.71*** (0.64 - 0.79)
2017	0.98 (0.93 - 1.02)	1.33*** (1.26 - 1.40)	0.51*** (0.46 - 0.56)
State			
Alaska	4.21*** (2.87 - 6.19)	3.41*** (1.99 - 5.85)	3.10*** (1.65 - 5.83)
Arizona	5.23*** (3.72 - 7.35)	4.47*** (2.70 - 7.40)	4.43*** (2.78 - 7.06)
Arkansas	1.16 (0.81 - 1.67)	1.06 (0.62 - 1.82)	1 (0.62 - 1.64)
Colorado	2.37*** (1.68 - 3.35)	1.83* (1.10 - 3.04)	2.19*** (1.38 - 3.49)
Connecticut	1.55* (1.10 - 2.20)	0.72 (0.43 - 1.21)	2.28*** (1.44 - 3.63)
Delaware	1.56* (1.11 - 2.20)	1.49 (0.90 - 2.48)	0.96 (0.61 - 1.53)
District of Columbia	4.66*** (2.86 - 7.61)	3.75*** (1.98 - 7.08)	4.18** (1.62 - 10.81)
Florida	1.65** (1.17 - 2.32)	0.99 (0.60 - 1.64)	2.04** (1.29 - 3.22)
Hawaii	0.82 (0.53 - 1.27)	0.40** (0.22 - 0.74)	5.68*** (2.11 - 15.32)
Idaho	2.56*** (1.73 - 3.76)	1.88* (1.10 - 3.22)	1.91 (0.66 - 5.47)
Illinois	1.29 (0.92 - 1.82)	1.04 (0.62 - 1.72)	1.21 (0.76 - 1.91)
Indiana	1.88*** (1.33 - 2.67)	1.56 (0.94 - 2.60)	1.79* (1.07 - 2.98)
Iowa	2.23*** (1.57 - 3.17)	1.77* (1.06 - 2.96)	2.34** (1.35 - 4.03)
Kansas	3.37*** (2.35 - 4.82)	2.69*** (1.61 - 4.51)	
Kentucky	0.17*** (0.12 - 0.24)	0.13*** (0.08 - 0.21)	0.22*** (0.14 - 0.35)
Louisiana	2.18*** (1.52 - 3.13)	1.97* (1.17 - 3.31)	0.55 (0.26 - 1.16)
Maine	2.30*** (1.63 - 3.24)	1.58 (0.95 - 2.65)	2.51*** (1.59 - 3.96)
Maryland	1.75**	1.43	1.47

	(1.24 - 2.46)	(0.86 - 2.37)	(0.93 - 2.32)
Massachusetts	2.17***	1.87*	1.89**
	(1.54 - 3.08)	(1.12 - 3.12)	(1.18 - 3.03)
Michigan	1.44*	1.06	1.65*
	(1.03 - 2.03)	(0.64 - 1.75)	(1.04 - 2.60)
Mississippi	1.16	0.83	1.96
	(0.80 - 1.67)	(0.49 - 1.40)	(0.78 - 4.89)
Missouri	1.67**	1.1	2.86***
	(1.18 - 2.37)	(0.66 - 1.84)	(1.76 - 4.66)
Montana	2.14***	1.70*	
	(1.48 - 3.08)	(1.01 - 2.87)	
Nebraska	1.02	0.83	0.74
	(0.66 - 1.58)	(0.46 - 1.48)	(0.27 - 2.02)
Nevada	3.20**	1.45	5.36**
	(1.53 - 6.71)	(0.46 - 4.52)	(1.79 - 16.04)
New Hampshire	1.24	0.9	2.09*
	(0.87 - 1.78)	(0.54 - 1.52)	(1.07 - 4.06)
New Jersey	1.90***	1.22	1.85**
	(1.35 - 2.68)	(0.74 - 2.03)	(1.18 - 2.92)
New Mexico	1.09	0.2	1.05
	(0.57 - 2.09)	(0.02 - 1.77)	(0.49 - 2.22)
New York	1.95***	1.61	1.85**
	(1.39 - 2.73)	(0.97 - 2.65)	(1.18 - 2.92)
North Carolina	0.59**	0.49**	0.54**
	(0.42 - 0.83)	(0.30 - 0.82)	(0.35 - 0.85)
North Dakota	2.46**	1.99	
	(1.27 - 4.75)	(0.93 - 4.26)	
Ohio	2.19***	1.82*	1.93**
	(1.56 - 3.08)	(1.10 - 3.02)	(1.22 - 3.05)
Oklahoma	4.69***	3.52***	
	(3.29 - 6.70)	(2.11 - 5.89)	
Pennsylvania	1.14	0.87	1.26
	(0.80 - 1.64)	(0.51 - 1.46)	(0.76 - 2.09)
Rhode Island	2.60***	1.27	3.08***
	(1.83 - 3.68)	(0.75 - 2.14)	(1.93 - 4.89)
South Carolina	2.09***	1.80*	1.57
	(1.47 - 2.97)	(1.08 - 3.00)	(0.87 - 2.83)
South Dakota	1.62*	1.31	1.27
	(1.01 - 2.60)	(0.72 - 2.41)	(0.38 - 4.17)
Tennessee	1.50*	1.14	1.08
	(1.05 - 2.15)	(0.68 - 1.90)	(0.09 - 12.77)
Utah	2.76***	2.50***	1.78*

	(1.96 - 3.89)	(1.51 - 4.14)	(1.11 - 2.85)
Washington	2.93***	2.10**	3.26***
	(2.08 - 4.13)	(1.27 - 3.49)	(2.06 - 5.17)
Wyoming	2.90***	2.10*	
	(1.73 - 4.86)	(1.11 - 3.98)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B2. DID model for the adjusted associations between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,272	164,420	60,849
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat	2.91***	2.09**	3.25***
Expansion states	(2.07 - 4.10)	(1.26 - 3.46)	(2.05 - 5.15)
Expansion	0.97	1.33***	0.51***
After the ACA implementation (2014)	(0.93 - 1.02)	(1.26 - 1.41)	(0.46 - 0.56)
Medicaid expansion	0.94**	0.94**	1.19***
Medicaid expansion	(0.90 - 0.98)	(0.89 - 0.98)	(1.08 - 1.31)
MAT (No= ref)	2.23***		
Yes	(2.18 - 2.29)		
Referral sources			
Healthcare provider referral	0.93***	1.01	0.88***
	(0.90 - 0.96)	(0.97 - 1.05)	(0.83 - 0.92)
Institutional referral	1.05**	1.22***	0.79***
	(1.02 - 1.09)	(1.17 - 1.26)	(0.74 - 0.85)
Court/criminal justice	1.88***	2.16***	0.74***
	(1.83 - 1.94)	(2.10 - 2.23)	(0.68 - 0.80)
Frequency of use (No past month use= ref)			
Some use	0.72***	0.70***	0.84***
	(0.69 - 0.74)	(0.68 - 0.72)	(0.78 - 0.90)
Daily use	0.67***	0.62***	0.84***
	(0.65 - 0.69)	(0.60 - 0.64)	(0.79 - 0.89)
Age (18-29= ref)			
30-44	1.07***	1.07***	1.09***
	(1.05 - 1.10)	(1.05 - 1.10)	(1.04 - 1.14)
45-64	1.30***	1.32***	1.31***
	(1.27 - 1.34)	(1.27 - 1.37)	(1.24 - 1.38)
Gender (Female=ref)			
Male	0.90***	0.89***	0.93***
	(0.88 - 0.92)	(0.87 - 0.92)	(0.89 - 0.96)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	0.94**	0.94*	0.93*

	(0.91 - 0.98)	(0.89 - 0.99)	(0.87 - 0.99)
Hispanic	1.01	0.94**	1.09**
	(0.97 - 1.05)	(0.89 - 0.98)	(1.02 - 1.16)
Other	1.01	1.01	0.99
	(0.96 - 1.07)	(0.94 - 1.08)	(0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98	1.00	0.96*
	(0.96 - 1.00)	(0.98 - 1.03)	(0.92 - 0.99)
Number of arrests (0= ref)			
1	0.96	1.04	0.79***
	(0.92 - 1.00)	(0.99 - 1.09)	(0.72 - 0.86)
2 or more	1.20***	1.18***	0.88
	(1.11 - 1.30)	(1.08 - 1.30)	(0.73 - 1.06)
Employment status (Unemployed= ref)			
Employed	0.80***	0.79***	0.84***
	(0.78 - 0.82)	(0.77 - 0.81)	(0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88***	0.89***	0.89***
	(0.86 - 0.90)	(0.87 - 0.92)	(0.85 - 0.92)
Homeless (No= ref)			
Yes	0.73***	0.76***	0.70***
	(0.70 - 0.76)	(0.72 - 0.81)	(0.64 - 0.75)
Polysubstance use (no= ref)			
One more	0.79***	0.79***	0.85***
	(0.77 - 0.81)	(0.77 - 0.81)	(0.82 - 0.89)
Two or more	0.72***	0.75***	0.76***
	(0.70 - 0.74)	(0.73 - 0.77)	(0.73 - 0.80)
Year			
2011	1.18***	1.23***	1.09*
	(1.13 - 1.22)	(1.18 - 1.29)	(1.01 - 1.17)
2012	1.15***	1.23***	1.06
	(1.11 - 1.20)	(1.17 - 1.28)	(0.98 - 1.15)
2013	1.18***	1.26***	1.06
	(1.14 - 1.23)	(1.20 - 1.32)	(0.98 - 1.15)
2014	1.51***	1.25***	1.76***
	(1.45 - 1.57)	(1.20 - 1.31)	(1.64 - 1.88)
2015	1.18***	1.02	1.35***
	(1.14 - 1.23)	(0.97 - 1.07)	(1.27 - 1.44)
2016	1.22***	1.05*	1.41***
	(1.17 - 1.26)	(1.01 - 1.10)	(1.32 - 1.49)
2017	-	-	-
State			
Arizona	1.79***	2.13***	1.36***

	(1.67 - 1.92)	(1.95 - 2.32)	(1.18 - 1.58)
Arkansas	0.40***	0.51***	0.31***
	(0.34 - 0.46)	(0.41 - 0.62)	(0.25 - 0.38)
Colorado	0.81***	0.87*	0.68***
	(0.74 - 0.89)	(0.78 - 0.98)	(0.59 - 0.78)
Connecticut	0.53***	0.34***	0.70***
	(0.48 - 0.58)	(0.30 - 0.39)	(0.61 - 0.81)
Delaware	0.53***	0.70***	0.30***
	(0.49 - 0.58)	(0.63 - 0.78)	(0.26 - 0.34)
District of Columbia	1.59*	1.78**	1.28
	(1.11 - 2.28)	(1.19 - 2.65)	(0.55 - 2.97)
Florida	1.64**	0.99	2.04**
	(1.16 - 2.31)	(0.59 - 1.63)	(1.29 - 3.21)
Hawaii	0.28***	0.19***	1.74
	(0.21 - 0.37)	(0.13 - 0.27)	(0.72 - 4.24)
Idaho	2.56***	1.88*	1.9
	(1.74 - 3.77)	(1.10 - 3.21)	(0.66 - 5.45)
Illinois	0.44***	0.49***	0.37***
	(0.41 - 0.48)	(0.44 - 0.54)	(0.33 - 0.42)
Iowa	0.76***	0.85**	0.72*
	(0.68 - 0.86)	(0.75 - 0.96)	(0.52 - 0.99)
Kansas	3.37***	2.69***	
	(2.35 - 4.82)	(1.61 - 4.50)	
Kentucky	0.06***	0.06***	0.07***
	(0.05 - 0.06)	(0.06 - 0.07)	(0.06 - 0.08)
Maine	2.30***	1.58	2.51***
	(1.63 - 3.24)	(0.95 - 2.64)	(1.59 - 3.96)
Maryland	0.60***	0.68***	0.45***
	(0.55 - 0.64)	(0.62 - 0.75)	(0.41 - 0.51)
Massachusetts	0.74***	0.89	0.58***
	(0.67 - 0.82)	(0.79 - 1.00)	(0.49 - 0.69)
Michigan	0.49***	0.50***	0.51***
	(0.46 - 0.53)	(0.46 - 0.55)	(0.45 - 0.57)
Mississippi	1.16	0.83	1.96
	(0.80 - 1.68)	(0.49 - 1.40)	(0.79 - 4.90)
Missouri	1.67**	1.1	2.86***
	(1.18 - 2.37)	(0.66 - 1.83)	(1.76 - 4.65)
Nebraska	1.02	0.82	0.74
	(0.66 - 1.58)	(0.46 - 1.47)	(0.27 - 2.02)
Nevada	1.09	0.68	1.64
	(0.56 - 2.11)	(0.25 - 1.91)	(0.60 - 4.47)
New Hampshire	0.42***	0.43***	0.64
	(0.37 - 0.49)	(0.37 - 0.50)	(0.39 - 1.05)
New Jersey	0.65***	0.58***	0.57***
	(0.60 - 0.70)	(0.52 - 0.64)	(0.51 - 0.63)
New Mexico	0.37***	0.10*	0.32***

New York	(0.21 - 0.65) 0.67***	(0.01 - 0.79) 0.77***	(0.18 - 0.59) 0.57***
North Carolina	(0.63 - 0.71) 0.59**	(0.71 - 0.83) 0.49**	(0.52 - 0.63) 0.54**
North Dakota	(0.42 - 0.83) 0.84	(0.30 - 0.81) 0.95	(0.35 - 0.85)
Ohio	(0.47 - 1.48) 0.75***	(0.53 - 1.69) 0.87***	0.59***
Oklahoma	(0.70 - 0.80) 4.70***	(0.80 - 0.94) 3.52***	(0.53 - 0.67)
Rhode Island	(3.29 - 6.71) 0.89*	(2.11 - 5.89) 0.60***	0.95
South Carolina	(0.80 - 0.98) 2.08***	(0.51 - 0.71) 1.79*	(0.82 - 1.09) 1.57
South Dakota	(1.47 - 2.96) 1.62*	(1.08 - 2.99) 1.31	(0.87 - 2.82) 1.27
Tennessee	(1.01 - 2.60) 1.50*	(0.71 - 2.41) 1.13	(0.39 - 4.17) 1.07
Utah	(1.05 - 2.15) 2.76***	(0.68 - 1.90) 2.49***	(0.09 - 12.71) 1.78*
Washington	(1.96 - 3.89) -	(1.50 - 4.13) -	(1.11 - 2.84) -
Wyoming	2.92*** (1.74 - 4.89)	2.11* (1.11 - 4.00)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B3. 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	Pooled model	Non-MAT	MAT
N	231,021	169,447	61,571
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion	0.84***	1.02	0.48***
Expansion	(0.80 - 0.87)	(0.97 - 1.06)	(0.43 - 0.54)
MAT (No= ref)			
Yes	0.86*** (0.84 - 0.88)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.14*** (1.08 - 1.21)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.15*** (1.07 - 1.24)
Court/criminal justice	2.03*** (1.98 - 2.09)	2.00*** (1.94 - 2.06)	1.89*** (1.73 - 2.06)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.71 - 0.76)	0.76*** (0.73 - 0.78)	0.70*** (0.65 - 0.76)
Daily use	0.77*** (0.75 - 0.79)	0.85*** (0.83 - 0.88)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.08)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	0.99 (0.93 - 1.05)
Gender (Female=ref)			
Male	0.93*** (0.92 - 0.95)	0.97** (0.95 - 0.99)	0.81*** (0.78 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.82***	0.94*	0.68***

	(0.79 - 0.86)	(0.90 - 0.99)	(0.63 - 0.73)
Hispanic	0.85***	0.92***	0.81***
	(0.82 - 0.89)	(0.88 - 0.97)	(0.75 - 0.86)
Other	0.73***	0.76***	0.69***
	(0.69 - 0.77)	(0.72 - 0.81)	(0.61 - 0.78)
Education (Less than high school= ref)			
Highschool or higher	1.19***	1.17***	1.20***
	(1.16 - 1.21)	(1.14 - 1.20)	(1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15***	1.19***	1.04
	(1.10 - 1.20)	(1.13 - 1.24)	(0.94 - 1.14)
2 or more	0.84***	0.89*	1.03
	(0.78 - 0.91)	(0.81 - 0.97)	(0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.03*	1.06***	0.97
	(1.01 - 1.05)	(1.03 - 1.09)	(0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89***	0.87***	0.95*
	(0.88 - 0.91)	(0.85 - 0.89)	(0.91 - 0.99)
Homeless (No= ref)			
Yes	1.10***	1.14***	1.02
	(1.06 - 1.15)	(1.08 - 1.20)	(0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.12***	1.13***	1.02
	(1.10 - 1.14)	(1.11 - 1.16)	(0.98 - 1.07)
Two or more	1.21***	1.22***	1.07*
	(1.18 - 1.24)	(1.18 - 1.25)	(1.01 - 1.13)
Year			
2011	1.02	1.04	0.95
	(0.98 - 1.06)	(0.99 - 1.08)	(0.87 - 1.03)
2012	1	1.03	0.96
	(0.96 - 1.04)	(0.99 - 1.08)	(0.88 - 1.04)
2013	0.93***	0.96	0.87***
	(0.89 - 0.96)	(0.92 - 1.01)	(0.79 - 0.94)
2014	0.97	0.88***	1.56***
	(0.92 - 1.01)	(0.83 - 0.92)	(1.38 - 1.77)
2015	0.96	0.90***	1.40***
	(0.92 - 1.01)	(0.85 - 0.95)	(1.24 - 1.59)
2016	1.11***	1.06*	1.62***

2017	(1.06 - 1.17) 1.55*** (1.49 - 1.63)	(1.01 - 1.12) 1.42*** (1.35 - 1.49)	(1.43 - 1.83) 2.12*** (1.88 - 2.38)
State			
Alaska	1.51* (1.03 - 2.21)	1.53 (0.91 - 2.59)	0.94 (0.47 - 1.91)
Arizona	0.64* (0.45 - 0.90)	0.49** (0.30 - 0.81)	1.45 (0.88 - 2.38)
Arkansas	1.87*** (1.30 - 2.70)	2.23** (1.32 - 3.76)	1.91* (1.13 - 3.22)
Colorado	2.66*** (1.88 - 3.76)	2.17** (1.32 - 3.58)	4.38*** (2.68 - 7.17)
Connecticut	4.01*** (2.83 - 5.68)	3.23*** (1.95 - 5.33)	6.53*** (3.99 - 10.70)
Delaware	1.64** (1.16 - 2.32)	1.24 (0.75 - 2.03)	3.27*** (2.00 - 5.36)
District of Columbia	3.07*** (1.92 - 4.92)	1.99* (1.08 - 3.68)	7.60*** (3.26 - 17.73)
Florida	8.54*** (6.04 - 12.06)	3.41*** (2.08 - 5.59)	43.97*** (26.61 - 72.64)
Hawaii	5.05*** (3.23 - 7.88)	5.02*** (2.79 - 9.05)	4.04*** (1.77 - 9.18)
Idaho	2.06*** (1.39 - 3.03)	2.09** (1.24 - 3.54)	2.16 (0.74 - 6.29)
Illinois	1.03 (0.73 - 1.45)	0.96 (0.59 - 1.57)	1.6 (0.98 - 2.61)
Indiana	0.66* (0.47 - 0.94)	0.65 (0.39 - 1.07)	0.45* (0.25 - 0.83)
Iowa	1.28 (0.89 - 1.82)	1.26 (0.76 - 2.07)	0.41* (0.20 - 0.82)
Kansas	1.61** (1.12 - 2.31)	1.53 (0.92 - 2.52)	
Kentucky	13.44*** (9.55 - 18.90)	12.31*** (7.54 - 20.10)	16.20*** (9.95 - 26.36)
Louisiana	1.4 (0.97 - 2.01)	1.19 (0.72 - 1.97)	6.40*** (2.98 - 13.74)
Maine	0.91 (0.64 - 1.28)	0.83 (0.51 - 1.38)	1.01 (0.62 - 1.63)
Maryland	1.34 (0.95 - 1.89)	1.36 (0.83 - 2.23)	1.80* (1.11 - 2.93)
Massachusetts	1.21 (0.85 - 1.71)	1.15 (0.70 - 1.89)	1.34 (0.80 - 2.23)

Michigan	1.37 (0.97 - 1.93)	1.12 (0.68 - 1.82)	2.31*** (1.42 - 3.76)
Mississippi	1.50* (1.04 - 2.17)	1.52 (0.91 - 2.53)	0.32 (0.10 - 1.04)
Missouri	1.84*** (1.30 - 2.62)	2.08** (1.26 - 3.43)	1.45 (0.87 - 2.42)
Montana	1.70** (1.18 - 2.46)	1.59 (0.96 - 2.65)	
Nebraska	4.95*** (3.11 - 7.85)	4.74*** (2.63 - 8.56)	6.73*** (2.26 - 20.06)
Nevada	2.27* (1.11 - 4.61)	2.73 (0.88 - 8.51)	2.72* (1.05 - 7.08)
New Hampshire	6.37*** (4.40 - 9.21)	5.70*** (3.42 - 9.51)	5.71*** (2.85 - 11.45)
New Jersey	1.09 (0.77 - 1.53)	1.75* (1.06 - 2.87)	1.18 (0.73 - 1.92)
New Mexico	8.61*** (4.20 - 17.65)	1.82 (0.44 - 7.46)	18.17*** (7.52 - 43.91)
New York	0.85 (0.60 - 1.19)	0.8 (0.49 - 1.30)	1.14 (0.70 - 1.86)
North Carolina	4.50*** (3.20 - 6.31)	3.83*** (2.35 - 6.24)	12.85*** (7.95 - 20.78)
North Dakota	2.58** (1.33 - 5.01)	2.39* (1.13 - 5.05)	
Ohio	0.91 (0.64 - 1.27)	0.94 (0.57 - 1.53)	0.66 (0.40 - 1.08)
Oklahoma	1.44* (1.01 - 2.05)	1.43 (0.87 - 2.36)	
Pennsylvania	1.17 (0.82 - 1.68)	1.29 (0.77 - 2.14)	0.75 (0.43 - 1.32)
Rhode Island	1.74** (1.22 - 2.46)	1.38 (0.83 - 2.30)	2.73*** (1.67 - 4.46)
South Carolina	1.58* (1.11 - 2.25)	1.5 (0.91 - 2.46)	1.35 (0.73 - 2.49)
South Dakota	2.53*** (1.57 - 4.08)	2.54** (1.39 - 4.64)	2.71 (0.78 - 9.47)
Tennessee	0.77 (0.54 - 1.11)	0.76 (0.46 - 1.25)	
Utah	2.17*** (1.53 - 3.06)	2.30*** (1.40 - 3.77)	1.68* (1.02 - 2.76)
Washington	1.98*** (1.41 - 2.80)	1.77* (1.08 - 2.90)	3.00*** (1.84 - 4.90)

Wyoming	2.16** (1.29 - 3.62)	2.16* (1.15 - 4.04)	1.68 (0.14 - 19.57)
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Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B4. DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,268	164,418	60,847
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	1.58*** (1.51 - 1.65)	1.45*** (1.38 - 1.52)	2.12*** (1.89 - 2.39)
Expansion			
After the ACA implementation (2014)	2.00*** (1.42 - 2.82)	1.78* (1.09 - 2.91)	3.01*** (1.85 - 4.91)
Medicaid expansion			
Expansion	0.83*** (0.80 - 0.87)	1.02 (0.97 - 1.07)	0.48*** (0.43 - 0.54)
MAT (No= ref)			
Yes	0.87*** (0.85 - 0.89)		
Referral sources			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.06*** (1.02 - 1.09)	1.15*** (1.09 - 1.22)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.16*** (1.07 - 1.25)
Court/criminal justice	2.05*** (2.00 - 2.11)	2.03*** (1.97 - 2.09)	1.89*** (1.73 - 2.07)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.72 - 0.76)	0.77*** (0.74 - 0.79)	0.70*** (0.65 - 0.75)
Daily use	0.79*** (0.77 - 0.81)	0.87*** (0.85 - 0.90)	0.58*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.08)	1.07*** (1.04 - 1.09)	1.03 (0.98 - 1.08)
45-64	1.11*** (1.08 - 1.14)	1.22*** (1.18 - 1.27)	0.91** (0.86 - 0.96)
Gender (Female=ref)			
Male	0.92*** (0.90 - 0.94)	0.96*** (0.94 - 0.98)	0.80*** (0.77 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			

Non-Hispanic Black	0.82*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.88)	0.92** (0.88 - 0.97)	0.80*** (0.75 - 0.86)
Other	0.74*** (0.70 - 0.78)	0.78*** (0.73 - 0.83)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.16*** (1.11 - 1.21)	1.20*** (1.14 - 1.26)	1.03 (0.94 - 1.14)
2 or more	0.84*** (0.77 - 0.91)	0.89* (0.81 - 0.97)	1.04 (0.83 - 1.30)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.04 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.87 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.11*** (1.06 - 1.16)	1.15*** (1.09 - 1.21)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.13*** (1.10 - 1.15)	1.14*** (1.11 - 1.17)	1.02 (0.98 - 1.07)
Two or more	1.22*** (1.19 - 1.25)	1.22*** (1.19 - 1.26)	1.07* (1.01 - 1.13)
Year			
2011	1.01 (0.98 - 1.05)	1.03 (0.99 - 1.08)	0.96 (0.88 - 1.04)
2012	1 (0.96 - 1.04)	1.04 (0.99 - 1.08)	0.96 (0.88 - 1.05)
2013	0.92*** (0.89 - 0.96)	0.97 (0.92 - 1.01)	0.85*** (0.78 - 0.93)
2014	0.62*** (0.60 - 0.64)	0.61*** (0.59 - 0.64)	0.74*** (0.68 - 0.80)
2015	0.61*** (0.59 - 0.64)	0.63*** (0.60 - 0.65)	0.66*** (0.61 - 0.71)
2016	0.71*** (0.68 - 0.73)	0.74*** (0.71 - 0.77)	0.77*** (0.72 - 0.82)
2017	-	-	-
State			
Arizona	0.32***	0.28***	0.48***

	(0.30 - 0.35)	(0.25 - 0.30)	(0.42 - 0.55)
Arkansas	0.94	1.26*	0.64***
	(0.82 - 1.09)	(1.03 - 1.53)	(0.51 - 0.79)
Colorado	1.34***	1.23***	1.46***
	(1.23 - 1.46)	(1.10 - 1.38)	(1.28 - 1.67)
Connecticut	2.03***	1.82***	2.18***
	(1.85 - 2.22)	(1.59 - 2.08)	(1.91 - 2.49)
Delaware	0.83***	0.70***	1.09
	(0.76 - 0.90)	(0.63 - 0.78)	(0.95 - 1.25)
District of Columbia	1.56**	1.12	2.53**
	(1.12 - 2.17)	(0.77 - 1.64)	(1.25 - 5.10)
Florida	8.60***	3.44***	44.04***
	(6.09 - 12.16)	(2.10 - 5.64)	(26.65 - 72.78)
Hawaii	2.55***	2.81***	1.35
	(1.90 - 3.41)	(2.01 - 3.94)	(0.69 - 2.64)
Idaho	2.07***	2.10**	2.16
	(1.40 - 3.05)	(1.24 - 3.55)	(0.74 - 6.29)
Illinois	0.52***	0.54***	0.53***
	(0.48 - 0.56)	(0.49 - 0.60)	(0.47 - 0.60)
Iowa	0.64***	0.71***	0.14***
	(0.58 - 0.72)	(0.63 - 0.80)	(0.08 - 0.23)
Kansas	1.62**	1.53	
	(1.13 - 2.33)	(0.93 - 2.53)	
Kentucky	6.81***	6.97***	5.38***
	(6.40 - 7.24)	(6.44 - 7.54)	(4.81 - 6.00)
Maine	0.91	0.84	1.01
	(0.65 - 1.29)	(0.51 - 1.39)	(0.62 - 1.64)
Maryland	0.68***	0.77***	0.60***
	(0.63 - 0.73)	(0.70 - 0.85)	(0.54 - 0.67)
Massachusetts	0.61***	0.64***	0.45***
	(0.55 - 0.67)	(0.57 - 0.72)	(0.37 - 0.54)
Michigan	0.69***	0.63***	0.77***
	(0.64 - 0.74)	(0.57 - 0.68)	(0.69 - 0.86)
Mississippi	1.50*	1.51	0.32
	(1.04 - 2.16)	(0.91 - 2.51)	(0.10 - 1.04)
Missouri	1.86***	2.11**	1.45
	(1.31 - 2.64)	(1.28 - 3.48)	(0.87 - 2.43)
Nebraska	4.98***	4.76***	6.74***
	(3.14 - 7.91)	(2.64 - 8.60)	(2.26 - 20.11)
Nevada	1.14	1.52	0.91
	(0.61 - 2.13)	(0.54 - 4.26)	(0.40 - 2.08)
New Hampshire	3.22***	3.21***	1.90*
	(2.77 - 3.75)	(2.72 - 3.79)	(1.14 - 3.16)
New Jersey	0.55***	0.99	0.39***
	(0.51 - 0.59)	(0.89 - 1.10)	(0.35 - 0.44)
New Mexico	4.35***	1.02	6.07***

New York	(2.30 - 8.19) 0.43*** (0.41 - 0.46)	(0.27 - 3.86) 0.45*** (0.42 - 0.49)	(2.89 - 12.79) 0.38*** (0.35 - 0.42)
North Carolina	4.53*** (3.22 - 6.36)	3.84*** (2.36 - 6.27)	12.87*** (7.96 - 20.81)
North Dakota	1.3 (0.74 - 2.31)	1.35 (0.76 - 2.39)	
Ohio	0.46*** (0.43 - 0.49)	0.53*** (0.49 - 0.58)	0.22*** (0.19 - 0.25)
Oklahoma	1.45* (1.01 - 2.07)	1.44 (0.87 - 2.37)	
Rhode Island	0.88** (0.79 - 0.97)	0.78** (0.67 - 0.92)	0.91 (0.80 - 1.04)
South Carolina	1.60** (1.12 - 2.28)	1.51 (0.92 - 2.49)	1.34 (0.73 - 2.48)
South Dakota	2.56*** (1.59 - 4.13)	2.57** (1.41 - 4.69)	2.71 (0.77 - 9.45)
Tennessee	0.78 (0.54 - 1.12)	0.76 (0.46 - 1.26)	
Utah	2.18*** (1.54 - 3.08)	2.30*** (1.41 - 3.77)	1.68* (1.02 - 2.77)
Washington	-	-	-
Wyoming	2.17** (1.30 - 3.64)	2.16* (1.16 - 4.05)	1.68 (0.14 - 19.60)
Arizona	0.32*** (0.30 - 0.35)	0.28*** (0.25 - 0.30)	0.48*** (0.42 - 0.55)
Arkansas	0.94 (0.82 - 1.09)	1.26* (1.03 - 1.53)	0.64*** (0.51 - 0.79)
Colorado	1.34*** (1.23 - 1.46)	1.23*** (1.10 - 1.38)	1.46*** (1.28 - 1.67)
Connecticut	2.03*** (1.85 - 2.22)	1.82*** (1.59 - 2.08)	2.18*** (1.91 - 2.49)
Delaware	0.83*** (0.76 - 0.90)	0.70*** (0.63 - 0.78)	1.09 (0.95 - 1.25)
District of Columbia	1.56** (1.12 - 2.17)	1.12 (0.77 - 1.64)	2.53** (1.25 - 5.10)
Florida	8.60*** (6.09 - 12.16)	3.44*** (2.10 - 5.64)	44.04*** (26.65 - 72.78)
Hawaii	2.55*** (1.90 - 3.41)	2.81*** (2.01 - 3.94)	1.35 (0.69 - 2.64)
Idaho	2.07*** (1.40 - 3.05)	2.10** (1.24 - 3.55)	2.16 (0.74 - 6.29)
Illinois	0.52*** (0.48 - 0.56)	0.54*** (0.49 - 0.60)	0.53*** (0.47 - 0.60)
Iowa	0.64***	0.71***	0.14***

	(0.58 - 0.72)	(0.63 - 0.80)	(0.08 - 0.23)
Kansas	1.62**	1.53	
	(1.13 - 2.33)	(0.93 - 2.53)	
Kentucky	6.81***	6.97***	5.38***
	(6.40 - 7.24)	(6.44 - 7.54)	(4.81 - 6.00)
Maine	0.91	0.84	1.01
	(0.65 - 1.29)	(0.51 - 1.39)	(0.62 - 1.64)
Maryland	0.68***	0.77***	0.60***
	(0.63 - 0.73)	(0.70 - 0.85)	(0.54 - 0.67)
Massachusetts	0.61***	0.64***	0.45***
	(0.55 - 0.67)	(0.57 - 0.72)	(0.37 - 0.54)
Michigan	0.69***	0.63***	0.77***
	(0.64 - 0.74)	(0.57 - 0.68)	(0.69 - 0.86)
Mississippi	1.50*	1.51	0.32
	(1.04 - 2.16)	(0.91 - 2.51)	(0.10 - 1.04)
Missouri	1.86***	2.11**	1.45
	(1.31 - 2.64)	(1.28 - 3.48)	(0.87 - 2.43)
Nebraska	4.98***	4.76***	6.74***
	(3.14 - 7.91)	(2.64 - 8.60)	(2.26 - 20.11)
Nevada	1.14	1.52	0.91
	(0.61 - 2.13)	(0.54 - 4.26)	(0.40 - 2.08)
New Hampshire	3.22***	3.21***	1.90*
	(2.77 - 3.75)	(2.72 - 3.79)	(1.14 - 3.16)
New Jersey	0.55***	0.99	0.39***
	(0.51 - 0.59)	(0.89 - 1.10)	(0.35 - 0.44)
New Mexico	4.35***	1.02	6.07***
	(2.30 - 8.19)	(0.27 - 3.86)	(2.89 - 12.79)
New York	0.43***	0.45***	0.38***
	(0.41 - 0.46)	(0.42 - 0.49)	(0.35 - 0.42)
North Carolina	4.53***	3.84***	12.87***
	(3.22 - 6.36)	(2.36 - 6.27)	(7.96 - 20.81)
North Dakota	1.3	1.35	
	(0.74 - 2.31)	(0.76 - 2.39)	
Ohio	0.46***	0.53***	0.22***
	(0.43 - 0.49)	(0.49 - 0.58)	(0.19 - 0.25)
Oklahoma	1.45*	1.44	
	(1.01 - 2.07)	(0.87 - 2.37)	
Rhode Island	0.88**	0.78**	0.91
	(0.79 - 0.97)	(0.67 - 0.92)	(0.80 - 1.04)
South Carolina	1.60**	1.51	1.34
	(1.12 - 2.28)	(0.92 - 2.49)	(0.73 - 2.48)
South Dakota	2.56***	2.57**	2.71
	(1.59 - 4.13)	(1.41 - 4.69)	(0.77 - 9.45)
Tennessee	0.78	0.76	
	(0.54 - 1.12)	(0.46 - 1.26)	
Utah	2.18***	2.30***	1.68*

Washington	(1.54 - 3.08) -	(1.41 - 3.77) -	(1.02 - 2.77) -
Wyoming	2.17** (1.30 - 3.64)	2.16* (1.16 - 4.05)	1.68 (0.14 - 19.60)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B5. DID model for the adjusted associations between Medicaid expansion and length of stay (without controlling for referral sources)

	DID pooled model	DID Non-MAT	DID MAT
N	228,239	166,465	61,771
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.96*** (2.10 - 4.15)	2.09** (1.27 - 3.45)	3.35*** (2.12 - 5.30)
Expansion	0.98	1.30***	0.52***
After the ACA implementation (2014)	(0.93 - 1.02)	(1.23 - 1.37)	(0.47 - 0.58)
Medicaid expansion			
Expansion	0.96 (0.92 - 1.00)	0.96 (0.92 - 1.01)	1.17*** (1.07 - 1.29)
MAT (No= ref)			
Yes	1.95*** (1.90 - 1.99)		
Frequency of use (No past month use= ref)			
Some use	0.65*** (0.63 - 0.66)	0.61*** (0.59 - 0.63)	0.87*** (0.81 - 0.93)
Daily use	0.57*** (0.55 - 0.58)	0.49*** (0.48 - 0.51)	0.88*** (0.84 - 0.93)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.06*** (1.04 - 1.09)	1.09*** (1.05 - 1.14)
45-64	1.27*** (1.24 - 1.31)	1.28*** (1.24 - 1.32)	1.33*** (1.26 - 1.40)
Gender (Female=ref)			
Male	0.93*** (0.91 - 0.95)	0.93*** (0.91 - 0.95)	0.93*** (0.89 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96 (0.93 - 1.00)	0.97 (0.93 - 1.02)	0.93* (0.88 - 0.99)
Hispanic	1.03 (0.99 - 1.07)	0.97 (0.92 - 1.01)	1.09** (1.03 - 1.16)
Other	1.01 (0.96 - 1.07)	1.01 (0.95 - 1.08)	0.97 (0.87 - 1.09)

Education (Less than high school= ref)			
Highschool or higher	0.96*** (0.94 - 0.98)	0.97** (0.94 - 0.99)	0.96* (0.92 - 1.00)
Number of arrests (0= ref)			
1	1.07*** (1.03 - 1.12)	1.20*** (1.14 - 1.25)	0.75*** (0.69 - 0.82)
2 or more	1.21*** (1.12 - 1.31)	1.17*** (1.07 - 1.28)	0.86 (0.71 - 1.04)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.83*** (0.82 - 0.85)	0.82*** (0.80 - 0.84)	0.88*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.70*** (0.67 - 0.73)	0.72*** (0.68 - 0.76)	0.68*** (0.63 - 0.74)
Polysubstance use (no= ref)			
One more	0.78*** (0.76 - 0.80)	0.77*** (0.75 - 0.79)	0.85*** (0.81 - 0.88)
Two or more	0.72*** (0.70 - 0.74)	0.74*** (0.72 - 0.76)	0.75*** (0.72 - 0.79)
Year			
2011	1.19*** (1.14 - 1.23)	1.23*** (1.18 - 1.29)	1.11** (1.03 - 1.19)
2012	1.17*** (1.12 - 1.21)	1.24*** (1.18 - 1.30)	1.08 (1.00 - 1.16)
2013	1.21*** (1.16 - 1.26)	1.29*** (1.23 - 1.35)	1.09* (1.01 - 1.18)
2014	1.51*** (1.46 - 1.57)	1.29*** (1.23 - 1.34)	1.77*** (1.65 - 1.89)
2015	1.18*** (1.14 - 1.22)	1.04 (0.99 - 1.09)	1.35*** (1.26 - 1.44)
2016	1.22*** (1.18 - 1.26)	1.08** (1.03 - 1.12)	1.40*** (1.32 - 1.48)
2017	-	-	-
State			
Arizona	1.59*** (1.48 - 1.70)	1.75*** (1.62 - 1.90)	1.43*** (1.24 - 1.64)
Arkansas	0.39*** (0.34 - 0.45)	0.49*** (0.40 - 0.60)	0.32*** (0.26 - 0.39)

Colorado	0.81*** (0.75 - 0.89)	0.85** (0.76 - 0.95)	0.70*** (0.61 - 0.80)
Connecticut	0.55*** (0.50 - 0.60)	0.39*** (0.34 - 0.44)	0.75*** (0.65 - 0.85)
Delaware	0.55*** (0.50 - 0.59)	0.73*** (0.65 - 0.81)	0.31*** (0.27 - 0.35)
District of Columbia	1.44* (1.02 - 2.04)	1.58* (1.07 - 2.33)	1.14 (0.52 - 2.53)
Florida	1.70** (1.21 - 2.38)	1.02 (0.62 - 1.68)	2.19*** (1.39 - 3.45)
Hawaii	0.30*** (0.23 - 0.40)	0.21*** (0.15 - 0.29)	1.8 (0.74 - 4.36)
Idaho	3.14*** (2.13 - 4.61)	2.33** (1.37 - 3.96)	1.89 (0.66 - 5.41)
Illinois	0.44*** (0.41 - 0.47)	0.49*** (0.44 - 0.54)	0.38*** (0.34 - 0.43)
Iowa	0.75*** (0.67 - 0.83)	0.81*** (0.72 - 0.92)	0.73* (0.53 - 1.00)
Kansas	3.49*** (2.44 - 4.99)	2.73*** (1.64 - 4.54)	
Kentucky	0.06*** (0.06 - 0.06)	0.06*** (0.06 - 0.07)	0.07*** (0.06 - 0.07)
Maine	2.30*** (1.64 - 3.24)	1.51 (0.91 - 2.51)	2.68*** (1.70 - 4.22)
Maryland	0.61*** (0.57 - 0.66)	0.71*** (0.65 - 0.78)	0.47*** (0.42 - 0.53)
Massachusetts	0.79*** (0.72 - 0.87)	0.96 (0.86 - 1.08)	0.61*** (0.52 - 0.72)
Michigan	0.48*** (0.45 - 0.51)	0.48*** (0.44 - 0.53)	0.51*** (0.46 - 0.57)
Mississippi	1.14 (0.79 - 1.65)	0.79 (0.47 - 1.32)	2.18 (0.88 - 5.36)
Missouri	1.75** (1.24 - 2.48)	1.13 (0.68 - 1.87)	3.01*** (1.86 - 4.89)
Nebraska	1.07 (0.69 - 1.66)	0.83 (0.47 - 1.48)	0.75 (0.28 - 2.04)
Nevada	0.99 (0.52 - 1.90)	0.59 (0.22 - 1.62)	1.71 (0.63 - 4.63)
New Hampshire	0.44*** (0.39 - 0.51)	0.45*** (0.39 - 0.52)	0.61* (0.37 - 1.00)
New Jersey	0.69*** (0.64 - 0.74)	0.65*** (0.59 - 0.73)	0.59*** (0.53 - 0.66)
New Mexico	0.25*** (0.15 - 0.42)	0.05** (0.01 - 0.37)	0.26*** (0.15 - 0.47)
New York	0.64*** (0.60 - 0.68)	0.70*** (0.65 - 0.76)	0.58*** (0.53 - 0.64)

North Carolina	0.60** (0.43 - 0.84)	0.48** (0.29 - 0.79)	0.57* (0.36 - 0.89)
North Dakota	0.9 (0.52 - 1.58)	1.01 (0.58 - 1.78)	
Ohio	0.79*** (0.74 - 0.84)	0.90* (0.83 - 0.98)	0.59*** (0.52 - 0.66)
Oklahoma	4.94*** (3.47 - 7.04)	3.64*** (2.19 - 6.04)	
Rhode Island	0.89* (0.80 - 0.98)	0.60*** (0.51 - 0.71)	0.99 (0.86 - 1.14)
South Carolina	1.99*** (1.41 - 2.82)	1.65 (1.00 - 2.73)	1.53 (0.85 - 2.74)
South Dakota	1.75* (1.10 - 2.79)	1.37 (0.75 - 2.49)	1.19 (0.36 - 3.93)
Tennessee	1.80** (1.26 - 2.57)	1.36 (0.81 - 2.25)	0.99 (0.08 - 11.95)
Utah	3.13*** (2.22 - 4.40)	2.84*** (1.72 - 4.68)	1.86** (1.16 - 2.97)
Washington	-	-	-
Wyoming	2.80*** (1.68 - 4.66)	1.95* (1.04 - 3.67)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B6. DID model for the adjusted associations of Medicaid expansion and treatment completion (without controlling for referral sources)

	DID pooled model	DID non-MAT	DID MAT
N	228,235	166,463	61,769
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Treat			
Expansion states	2.02*** (1.43 - 2.84)	1.78* (1.09 - 2.91)	3.00*** (1.84 - 4.87)
Expansion	1.56***	1.40***	2.14***
After the ACA implementation (2014)	(1.50 - 1.64)	(1.33 - 1.47)	(1.90 - 2.40)
Medicaid expansion			
Expansion	0.87*** (0.83 - 0.91)	1.06* (1.01 - 1.11)	0.49*** (0.44 - 0.55)
MAT (No= ref)			
Yes	0.74*** (0.72 - 0.76)		
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.65 - 0.69)	0.69*** (0.67 - 0.71)	0.66*** (0.62 - 0.71)
Daily use	0.65*** (0.63 - 0.66)	0.71*** (0.70 - 0.73)	0.53*** (0.50 - 0.56)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.08)	1.06*** (1.04 - 1.09)	1.03 (0.99 - 1.08)
45-64	1.12*** (1.09 - 1.15)	1.20*** (1.16 - 1.25)	0.98 (0.93 - 1.04)
Gender (Female=ref)			
Male	0.95*** (0.94 - 0.97)	0.99 (0.97 - 1.02)	0.81*** (0.78 - 0.85)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.84*** (0.81 - 0.87)	0.97 (0.92 - 1.01)	0.68*** (0.63 - 0.73)
Hispanic	0.86*** (0.83 - 0.89)	0.94* (0.90 - 0.99)	0.78*** (0.73 - 0.84)
Other	0.74*** (0.70 - 0.78)	0.77*** (0.73 - 0.82)	0.68*** (0.60 - 0.77)

Education (Less than high school= ref)			
Highschool or higher	1.16*** (1.13 - 1.18)	1.13*** (1.10 - 1.16)	1.19*** (1.14 - 1.24)
Number of arrests (0= ref)			
1	1.28*** (1.23 - 1.34)	1.33*** (1.27 - 1.39)	1.11* (1.01 - 1.23)
2 or more	0.84*** (0.77 - 0.91)	0.87** (0.79 - 0.95)	1.08 (0.87 - 1.34)
Employment status (Unemployed= ref)			
Employed	1.02 (1.00 - 1.04)	1.05*** (1.02 - 1.07)	0.98 (0.94 - 1.02)
Comorbidity (No= ref)			
Yes	0.85*** (0.83 - 0.87)	0.81*** (0.79 - 0.83)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.08** (1.03 - 1.12)	1.09** (1.04 - 1.15)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.11*** (1.08 - 1.13)	1.11*** (1.08 - 1.14)	1.03 (0.99 - 1.08)
Two or more	1.21*** (1.18 - 1.24)	1.20*** (1.16 - 1.23)	1.10*** (1.04 - 1.16)
Year			
2011	1.02 (0.98 - 1.05)	1.03 (0.99 - 1.08)	0.96 (0.89 - 1.05)
2012	1.01 (0.97 - 1.05)	1.04* (1.00 - 1.09)	0.98 (0.90 - 1.07)
2013	0.95** (0.91 - 0.98)	0.99 (0.95 - 1.04)	0.87** (0.80 - 0.94)
2014	0.62*** (0.60 - 0.65)	0.63*** (0.61 - 0.66)	0.73*** (0.67 - 0.78)
2015	0.62*** (0.60 - 0.64)	0.64*** (0.61 - 0.67)	0.66*** (0.61 - 0.71)
2016	0.72*** (0.70 - 0.75)	0.77*** (0.73 - 0.80)	0.78*** (0.73 - 0.83)
2017	-	-	-
State			
Arizona	0.29*** (0.27 - 0.31)	0.24*** (0.22 - 0.26)	0.48*** (0.42 - 0.55)
Arkansas	0.91 (0.79 - 1.05)	1.2 (0.98 - 1.45)	0.63*** (0.50 - 0.78)
Colorado	1.30*** (1.19 - 1.41)	1.18** (1.06 - 1.32)	1.45*** (1.28 - 1.65)

Connecticut	1.92*** (1.75 - 2.10)	1.82*** (1.60 - 2.07)	2.04*** (1.79 - 2.32)
Delaware	0.84*** (0.77 - 0.91)	0.72*** (0.65 - 0.80)	1.07 (0.94 - 1.22)
District of Columbia	1.34 (0.97 - 1.85)	0.92 (0.64 - 1.33)	2.66** (1.35 - 5.27)
Florida	8.46*** (6.00 - 11.93)	3.46*** (2.11 - 5.65)	42.23*** (25.63 - 69.59)
Hawaii	2.54*** (1.90 - 3.39)	2.82*** (2.02 - 3.92)	1.33 (0.68 - 2.60)
Idaho	2.52*** (1.72 - 3.71)	2.52*** (1.50 - 4.25)	2.4 (0.83 - 6.92)
Illinois	0.50*** (0.47 - 0.54)	0.53*** (0.48 - 0.58)	0.52*** (0.46 - 0.59)
Iowa	0.61*** (0.55 - 0.68)	0.67*** (0.59 - 0.76)	0.14*** (0.08 - 0.23)
Kansas	1.65** (1.15 - 2.36)	1.55 (0.94 - 2.55)	
Kentucky	6.71*** (6.32 - 7.13)	6.84*** (6.34 - 7.38)	5.63*** (5.05 - 6.27)
Maine	0.89 (0.63 - 1.25)	0.81 (0.49 - 1.33)	0.98 (0.61 - 1.59)
Maryland	0.68*** (0.63 - 0.73)	0.80*** (0.72 - 0.87)	0.59*** (0.53 - 0.65)
Massachusetts	0.64*** (0.58 - 0.70)	0.68*** (0.61 - 0.77)	0.47*** (0.39 - 0.56)
Michigan	0.66*** (0.62 - 0.71)	0.60*** (0.55 - 0.65)	0.77*** (0.69 - 0.86)
Mississippi	1.45* (1.01 - 2.09)	1.46 (0.88 - 2.41)	0.31* (0.10 - 1.00)
Missouri	1.89*** (1.33 - 2.68)	2.10** (1.28 - 3.45)	1.43 (0.86 - 2.38)
Nebraska	4.99*** (3.15 - 7.89)	4.65*** (2.59 - 8.34)	7.20*** (2.45 - 21.18)
Nevada	0.99 (0.53 - 1.83)	1.19 (0.45 - 3.16)	0.85 (0.37 - 1.95)
New Hampshire	3.14*** (2.71 - 3.64)	3.11*** (2.65 - 3.65)	2.03** (1.23 - 3.36)
New Jersey	0.55*** (0.52 - 0.59)	1.09 (0.98 - 1.21)	0.38*** (0.34 - 0.42)
New Mexico	5.10*** (2.86 - 9.10)	2.44 (0.92 - 6.52)	7.22*** (3.47 - 15.03)
New York	0.41*** (0.38 - 0.43)	0.42*** (0.39 - 0.45)	0.38*** (0.35 - 0.42)
North Carolina	4.28*** (3.06 - 6.00)	3.57*** (2.20 - 5.81)	12.63*** (7.83 - 20.37)

North Dakota	1.37 (0.77 - 2.41)	1.41 (0.80 - 2.48)	
Ohio	0.49*** (0.46 - 0.53)	0.57*** (0.53 - 0.62)	0.24*** (0.21 - 0.27)
Oklahoma	1.52* (1.06 - 2.16)	1.5 (0.91 - 2.46)	
Rhode Island	0.84*** (0.77 - 0.93)	0.77*** (0.65 - 0.90)	0.88 (0.77 - 1.00)
South Carolina	1.55* (1.09 - 2.20)	1.43 (0.87 - 2.35)	1.32 (0.72 - 2.42)
South Dakota	2.67*** (1.67 - 4.29)	2.60** (1.43 - 4.72)	3.24 (0.94 - 11.09)
Tennessee	0.91 (0.64 - 1.31)	0.87 (0.53 - 1.44)	
Utah	2.42*** (1.72 - 3.42)	2.56*** (1.57 - 4.18)	1.69* (1.03 - 2.78)
Washington	-	-	-
Wyoming	2.04** (1.22 - 3.39)	2.00* (1.07 - 3.71)	1.81 (0.16 - 21.01)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B7. Sensitivity analysis with added covariates for the 2WFE model for the adjusted associations between Medicaid expansion and length of stay

	2 ways fixed effect pooled model	2 ways fixed effect Non-MAT	2 ways fixed effect MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.94** (0.90 - 0.98)	0.95 (0.91 - 1.00)	1.15** (1.04 - 1.26)
MAT (No= ref)			
Yes	2.22*** (2.16 - 2.27)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.04)	0.87*** (0.83 - 0.92)
Institutional referral	1.04* (1.01 - 1.08)	1.21*** (1.17 - 1.26)	0.77*** (0.72 - 0.83)
Court/criminal justice	1.87*** (1.82 - 1.92)	2.14*** (2.08 - 2.20)	0.74*** (0.69 - 0.81)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.70 - 0.74)	0.70*** (0.68 - 0.73)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.80 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.04 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.30*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.31*** (1.24 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.91)	0.89*** (0.87 - 0.91)	0.92*** (0.89 - 0.95)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94** (0.89 - 0.98)	0.92** (0.87 - 0.98)

Hispanic	1.01 (0.98 - 1.05)	0.94** (0.90 - 0.98)	1.09** (1.02 - 1.16)
Other	1.00 (0.95 - 1.06)	0.99 (0.93 - 1.06)	0.99 (0.89 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.97 (0.93 - 1.01)	1.04 (0.99 - 1.09)	0.79*** (0.73 - 0.86)
2 or more	1.18*** (1.09 - 1.28)	1.17*** (1.07 - 1.28)	0.86 (0.72 - 1.04)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.86)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.90*** (0.87 - 0.92)	0.89*** (0.86 - 0.93)
Homeless (No= ref)			
Yes	0.74*** (0.70 - 0.77)	0.77*** (0.73 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.80*** (0.78 - 0.81)	0.80*** (0.78 - 0.82)	0.86*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.74)	0.76*** (0.74 - 0.78)	0.76*** (0.72 - 0.80)
Unemployment rate			
Unemployment rate	0.98 (0.96 - 1.00)	0.95*** (0.92 - 0.97)	1.03 (0.99 - 1.07)
PMDP (No= ref)			
Yes	1.06* (1.01 - 1.12)	1.00 (0.92 - 1.07)	1.39*** (1.27 - 1.52)
Year			
2011	1.13*** (1.09 - 1.18)	1.16*** (1.11 - 1.22)	0.99 (0.91 - 1.08)
2012	1.10*** (1.05 - 1.16)	1.12*** (1.06 - 1.19)	0.99 (0.90 - 1.10)
2013	1.12*** (1.05 - 1.19)	1.12** (1.04 - 1.20)	0.96 (0.85 - 1.08)

2014	1.36*** (1.24 - 1.49)	1.36*** (1.21 - 1.51)	0.87 (0.72 - 1.05)
2015	1.04 (0.93 - 1.16)	1.04 (0.92 - 1.19)	0.70** (0.56 - 0.87)
2016	1.06 (0.94 - 1.19)	1.06 (0.92 - 1.21)	0.74* (0.58 - 0.93)
2017	0.87* (0.76 - 0.98)	0.97 (0.84 - 1.13)	0.54*** (0.42 - 0.69)
State			
Alaska	4.25*** (2.89 - 6.24)	3.42*** (2.00 - 5.88)	3.15*** (1.68 - 5.91)
Arizona	5.21*** (3.71 - 7.33)	4.38*** (2.65 - 7.25)	4.51*** (2.83 - 7.18)
Arkansas	1.16 (0.80 - 1.67)	0.98 (0.57 - 1.67)	1.14 (0.70 - 1.86)
Colorado	2.29*** (1.62 - 3.24)	1.64 (0.98 - 2.73)	2.29*** (1.43 - 3.66)
Connecticut	1.55* (1.09 - 2.18)	0.7 (0.42 - 1.17)	2.34*** (1.47 - 3.72)
Delaware	1.54* (1.09 - 2.18)	1.37 (0.82 - 2.28)	1.09 (0.69 - 1.74)
District of Columbia	4.84*** (2.96 - 7.91)	3.85*** (2.04 - 7.28)	5.31*** (2.05 - 13.78)
Florida	1.68** (1.20 - 2.37)	1 (0.60 - 1.66)	2.15** (1.36 - 3.40)
Hawaii	0.78 (0.50 - 1.21)	0.34*** (0.19 - 0.63)	6.11*** (2.25 - 16.58)
Idaho	2.49*** (1.69 - 3.66)	1.73* (1.01 - 2.96)	1.96 (0.68 - 5.64)
Illinois	1.3 (0.92 - 1.82)	1.04 (0.62 - 1.72)	1.21 (0.77 - 1.92)
Indiana	1.86*** (1.31 - 2.64)	1.51 (0.91 - 2.52)	1.80* (1.08 - 3.02)
Iowa	2.11*** (1.48 - 3.01)	1.5 (0.89 - 2.51)	2.50** (1.44 - 4.34)
Kansas	3.26*** (2.27 - 4.68)	2.36** (1.41 - 3.97)	
Kentucky	0.17*** (0.12 - 0.23)	0.12*** (0.07 - 0.20)	0.22*** (0.14 - 0.35)
Louisiana	2.11*** (1.46 - 3.03)	1.80* (1.07 - 3.03)	0.56 (0.26 - 1.17)
Maine	2.23***	1.46	2.57***

	(1.58 - 3.15)	(0.87 - 2.44)	(1.63 - 4.06)
Maryland	1.74**	1.29	1.81*
	(1.24 - 2.45)	(0.77 - 2.14)	(1.14 - 2.87)
Massachusetts	2.11***	1.71*	1.99**
	(1.49 - 2.99)	(1.02 - 2.84)	(1.24 - 3.22)
Michigan	1.45*	1.07	1.64*
	(1.03 - 2.04)	(0.65 - 1.77)	(1.04 - 2.59)
Mississippi	1.17	0.86	1.91
	(0.81 - 1.70)	(0.51 - 1.45)	(0.76 - 4.77)
Missouri	1.75**	1.04	4.06***
	(1.23 - 2.49)	(0.62 - 1.75)	(2.48 - 6.65)
Montana	2.08***	1.49	
	(1.44 - 3.01)	(0.88 - 2.52)	
Nebraska	0.96	0.69	0.87
	(0.61 - 1.50)	(0.38 - 1.24)	(0.31 - 2.39)
Nevada	3.23**	1.45	5.40**
	(1.54 - 6.78)	(0.46 - 4.52)	(1.80 - 16.15)
New Hampshire	1.2	0.77	2.47**
	(0.83 - 1.72)	(0.46 - 1.30)	(1.26 - 4.84)
New Jersey	1.91***	1.2	1.94**
	(1.36 - 2.68)	(0.72 - 1.98)	(1.23 - 3.05)
New Mexico	1.06	0.2	1.04
	(0.56 - 2.03)	(0.02 - 1.76)	(0.49 - 2.21)
New York	1.92***	1.53	1.89**
	(1.37 - 2.70)	(0.93 - 2.53)	(1.20 - 2.98)
North Carolina	0.59**	0.50**	0.53**
	(0.42 - 0.83)	(0.30 - 0.82)	(0.34 - 0.84)
North Dakota	2.21*	1.47	
	(1.13 - 4.32)	(0.68 - 3.19)	
Ohio	2.16***	1.75*	1.97**
	(1.54 - 3.03)	(1.06 - 2.89)	(1.24 - 3.11)
Oklahoma	4.54***	3.18***	
	(3.17 - 6.49)	(1.90 - 5.33)	
Pennsylvania	1.15	0.85	1.32
	(0.80 - 1.64)	(0.50 - 1.43)	(0.79 - 2.19)
Rhode Island	2.62***	1.31	3.02***
	(1.85 - 3.71)	(0.78 - 2.20)	(1.90 - 4.81)
South Carolina	2.09***	1.82*	1.58
	(1.47 - 2.97)	(1.09 - 3.03)	(0.87 - 2.84)
South Dakota	1.54	1.09	1.36
	(0.96 - 2.47)	(0.59 - 2.01)	(0.41 - 4.50)
Tennessee	1.49*	1.11	1.08

	(1.04 - 2.13)	(0.66 - 1.85)	(0.09 - 12.74)
Utah	2.63***	2.17**	1.87*
	(1.86 - 3.72)	(1.31 - 3.62)	(1.16 - 3.01)
Washington	2.91***	2.02**	3.42***
	(2.07 - 4.10)	(1.22 - 3.35)	(2.16 - 5.42)
Wyoming	2.87***	2.03*	
	(1.71 - 4.81)	(1.07 - 3.85)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B8. Sensitivity with added covariates for the DID model for the adjusted association between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,272	164,420	60,849
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.87*** (2.04 - 4.05)	1.98** (1.19 - 3.28)	3.40*** (2.15 - 5.39)
Expansion			
After the ACA implementation (2014)	0.81** (0.71 - 0.92)	0.91 (0.78 - 1.06)	0.53*** (0.41 - 0.68)
Medicaid expansion			
Expansion	0.95* (0.91 - 1.00)	0.98 (0.93 - 1.03)	1.15** (1.05 - 1.27)
MAT (No= ref)			
Yes	2.23*** (2.18 - 2.29)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.98 - 1.05)	0.87*** (0.83 - 0.92)
Institutional referral	1.05** (1.02 - 1.09)	1.22*** (1.17 - 1.27)	0.79*** (0.73 - 0.85)
Court/criminal justice	1.88*** (1.83 - 1.94)	2.16*** (2.10 - 2.23)	0.74*** (0.68 - 0.80)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.69 - 0.74)	0.70*** (0.68 - 0.72)	0.84*** (0.78 - 0.90)
Daily use	0.67*** (0.65 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.79 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.10)	1.07*** (1.05 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.30*** (1.27 - 1.34)	1.32*** (1.27 - 1.37)	1.30*** (1.24 - 1.38)
Gender (Female=ref)			
Male	0.90*** (0.88 - 0.92)	0.89*** (0.87 - 0.91)	0.93*** (0.89 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94**	0.94**	0.93*

	(0.91 - 0.98)	(0.89 - 0.98)	(0.87 - 0.99)
Hispanic	1.01	0.94**	1.08**
	(0.97 - 1.05)	(0.89 - 0.98)	(1.02 - 1.15)
Other	1.01	1.00	0.99
	(0.95 - 1.07)	(0.94 - 1.07)	(0.89 - 1.11)
Education (Less than high school= ref)			
Highschool or higher	0.98*	1.00	0.96*
	(0.96 - 1.00)	(0.98 - 1.03)	(0.92 - 0.99)
Number of arrests (0= ref)			
1	0.96	1.04	0.79***
	(0.92 - 1.00)	(0.99 - 1.10)	(0.72 - 0.86)
2 or more	1.20***	1.19***	0.86
	(1.10 - 1.29)	(1.08 - 1.30)	(0.71 - 1.04)
Employment status (Unemployed= ref)			
Employed	0.80***	0.79***	0.83***
	(0.78 - 0.82)	(0.77 - 0.81)	(0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88***	0.89***	0.89***
	(0.86 - 0.90)	(0.87 - 0.91)	(0.86 - 0.93)
Homeless (No= ref)			
Yes	0.73***	0.76***	0.70***
	(0.70 - 0.76)	(0.72 - 0.81)	(0.64 - 0.75)
Polysubstance use (no= ref)			
One more	0.79***	0.79***	0.85***
	(0.77 - 0.81)	(0.77 - 0.82)	(0.82 - 0.89)
Two or more	0.72***	0.75***	0.76***
	(0.70 - 0.74)	(0.73 - 0.78)	(0.72 - 0.80)
Unemployment rate			
Unemployment rate	0.97**	0.94***	1.03
	(0.95 - 0.99)	(0.91 - 0.96)	(0.99 - 1.07)
PMDP (No= ref)			
Yes	1.07*	1.00	1.40***
	(1.01 - 1.13)	(0.92 - 1.08)	(1.28 - 1.53)
Year			
2011	1.14***	1.17***	1
	(1.09 - 1.19)	(1.12 - 1.24)	(0.92 - 1.09)
2012	1.09***	1.12***	0.99
	(1.04 - 1.15)	(1.05 - 1.19)	(0.90 - 1.10)
2013	1.09**	1.10*	0.95
	(1.03 - 1.16)	(1.02 - 1.18)	(0.84 - 1.08)
2014	1.59***	1.41***	1.63***
	(1.51 - 1.68)	(1.32 - 1.50)	(1.46 - 1.81)
2015	1.21***	1.08**	1.31***
	(1.16 - 1.27)	(1.03 - 1.14)	(1.21 - 1.41)
2016	1.23***	1.09***	1.38***

2017	(1.19 - 1.28)	(1.04 - 1.14)	(1.30 - 1.47)
	-	-	-
State			
Arizona	1.80*** (1.68 - 1.94)	2.19*** (2.00 - 2.38)	1.32*** (1.14 - 1.53)
Arkansas	0.39*** (0.34 - 0.46)	0.48*** (0.39 - 0.59)	0.33*** (0.27 - 0.41)
Colorado	0.78*** (0.71 - 0.86)	0.80*** (0.71 - 0.90)	0.67*** (0.58 - 0.78)
Connecticut	0.53*** (0.49 - 0.58)	0.35*** (0.30 - 0.40)	0.69*** (0.60 - 0.79)
Delaware	0.52*** (0.48 - 0.57)	0.67*** (0.60 - 0.75)	0.32*** (0.28 - 0.37)
District of Columbia	1.69** (1.18 - 2.42)	1.94** (1.30 - 2.89)	1.56 (0.67 - 3.64)
Florida	1.68** (1.19 - 2.37)	0.99 (0.60 - 1.65)	2.15*** (1.36 - 3.40)
Hawaii	0.26*** (0.20 - 0.35)	0.16*** (0.12 - 0.23)	1.79 (0.73 - 4.36)
Idaho	2.45*** (1.66 - 3.61)	1.69 (0.99 - 2.90)	1.95 (0.68 - 5.61)
Illinois	0.45*** (0.41 - 0.48)	0.52*** (0.47 - 0.57)	0.36*** (0.32 - 0.40)
Iowa	0.71*** (0.63 - 0.80)	0.73*** (0.63 - 0.83)	0.73 (0.53 - 1.02)
Kansas	3.19*** (2.22 - 4.57)	2.29** (1.36 - 3.85)	
Kentucky	0.06*** (0.05 - 0.06)	0.06*** (0.06 - 0.07)	0.07*** (0.06 - 0.07)
Maine	2.20*** (1.56 - 3.10)	1.43 (0.85 - 2.39)	2.57*** (1.62 - 4.06)
Maryland	0.59*** (0.55 - 0.64)	0.63*** (0.57 - 0.70)	0.53*** (0.47 - 0.60)
Massachusetts	0.72*** (0.65 - 0.80)	0.84** (0.74 - 0.95)	0.59*** (0.49 - 0.70)
Michigan	0.50*** (0.47 - 0.54)	0.54*** (0.49 - 0.59)	0.48*** (0.43 - 0.54)
Mississippi	1.18 (0.82 - 1.72)	0.86 (0.51 - 1.46)	1.91 (0.77 - 4.79)
Missouri	1.74** (1.22 - 2.48)	1.03 (0.61 - 1.73)	4.08*** (2.49 - 6.69)
Nebraska	0.93 (0.59 - 1.45)	0.66 (0.36 - 1.18)	0.87 (0.31 - 2.39)
Nevada	1.12 (0.58 - 2.17)	0.72 (0.26 - 2.01)	1.58 (0.58 - 4.31)

New Hampshire	0.40*** (0.35 - 0.47)	0.37*** (0.32 - 0.43)	0.72 (0.44 - 1.20)
New Jersey	0.66*** (0.61 - 0.71)	0.59*** (0.53 - 0.66)	0.57*** (0.51 - 0.63)
New Mexico	0.36*** (0.21 - 0.63)	0.10* (0.01 - 0.82)	0.31*** (0.17 - 0.56)
New York	0.66*** (0.62 - 0.70)	0.76*** (0.70 - 0.82)	0.56*** (0.50 - 0.61)
North Carolina	0.59** (0.42 - 0.83)	0.50** (0.30 - 0.82)	0.53** (0.34 - 0.84)
North Dakota	0.72 (0.41 - 1.29)	0.69 (0.38 - 1.24)	
Ohio	0.74*** (0.69 - 0.79)	0.86*** (0.79 - 0.94)	0.58*** (0.51 - 0.65)
Oklahoma	4.46*** (3.12 - 6.38)	3.11*** (1.86 - 5.21)	
Rhode Island	0.91 (0.82 - 1.01)	0.66*** (0.56 - 0.78)	0.89 (0.76 - 1.03)
South Carolina	2.09*** (1.47 - 2.97)	1.81* (1.09 - 3.02)	1.57 (0.87 - 2.82)
South Dakota	1.49 (0.92 - 2.39)	1.05 (0.57 - 1.93)	1.36 (0.41 - 4.49)
Tennessee	1.48* (1.04 - 2.12)	1.1 (0.66 - 1.84)	1.07 (0.09 - 12.68)
Utah	2.57*** (1.81 - 3.63)	2.10** (1.26 - 3.50)	1.86* (1.15 - 3.00)
Washington	-	-	-
Wyoming	2.87*** (1.71 - 4.82)	2.03* (1.07 - 3.84)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B9. Sensitivity analysis with added covariates for the 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	229,288	168,163	61,122
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion	0.84***	1.03	0.47***
Expansion	(0.81 - 0.88)	(0.99 - 1.09)	(0.42 - 0.52)
MAT (No= ref)			
Yes	0.86*** (0.84 - 0.88)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.14*** (1.08 - 1.21)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.15*** (1.06 - 1.24)
Court/criminal justice	2.03*** (1.98 - 2.09)	2.00*** (1.95 - 2.06)	1.89*** (1.73 - 2.06)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.71 - 0.76)	0.76*** (0.73 - 0.78)	0.70*** (0.65 - 0.76)
Daily use	0.77*** (0.75 - 0.79)	0.85*** (0.83 - 0.88)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.08)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	0.99 (0.93 - 1.05)
Gender (Female=ref)			
Male	0.93*** (0.92 - 0.95)	0.97** (0.95 - 0.99)	0.81*** (0.78 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			

Non-Hispanic Black	0.82*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.89)	0.92*** (0.88 - 0.96)	0.81*** (0.75 - 0.87)
Other	0.73*** (0.69 - 0.77)	0.76*** (0.72 - 0.81)	0.69*** (0.61 - 0.78)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.19*** (1.13 - 1.24)	1.03 (0.94 - 1.14)
2 or more	0.84*** (0.77 - 0.91)	0.89** (0.81 - 0.97)	1.02 (0.82 - 1.28)
Employment status (Unemployed= ref)			
Employed	1.03* (1.00 - 1.05)	1.06*** (1.03 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.88 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 1.00)
Homeless (No= ref)			
Yes	1.11*** (1.06 - 1.15)	1.14*** (1.08 - 1.20)	1.03 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.12*** (1.10 - 1.14)	1.14*** (1.11 - 1.17)	1.02 (0.98 - 1.07)
Two or more	1.21*** (1.18 - 1.24)	1.22*** (1.18 - 1.25)	1.06* (1.01 - 1.12)
Unemployment rate			
Unemployment rate	0.98* (0.96 - 1.00)	0.96** (0.94 - 0.98)	1.06* (1.01 - 1.11)
PMDP (No= ref)			
Yes	1.11*** (1.05 - 1.18)	1.13** (1.05 - 1.22)	1.17** (1.05 - 1.30)
Year			
2011	0.99 (0.95 - 1.03)	0.99 (0.95 - 1.04)	0.95 (0.86 - 1.04)
2012	0.95	0.96	0.99

	(0.91 - 1.00)	(0.91 - 1.02)	(0.88 - 1.10)
2013	0.87***	0.87***	0.9
	(0.81 - 0.92)	(0.81 - 0.93)	(0.79 - 1.03)
2014	0.88**	0.74***	1.80***
	(0.80 - 0.96)	(0.66 - 0.82)	(1.47 - 2.22)
2015	0.86**	0.73***	1.74***
	(0.77 - 0.96)	(0.64 - 0.83)	(1.37 - 2.21)
2016	0.98	0.85*	2.07***
	(0.87 - 1.11)	(0.74 - 0.97)	(1.59 - 2.68)
2017	1.36***	1.12	2.78***
	(1.20 - 1.54)	(0.97 - 1.29)	(2.11 - 3.65)
State			
Alaska	1.53*	1.55	0.94
	(1.04 - 2.24)	(0.92 - 2.61)	(0.47 - 1.92)
Arizona	0.64*	0.49**	1.47
	(0.45 - 0.90)	(0.30 - 0.80)	(0.90 - 2.41)
Arkansas	1.89***	2.22**	2.14**
	(1.31 - 2.73)	(1.31 - 3.75)	(1.27 - 3.63)
Colorado	2.57***	2.02**	4.80***
	(1.81 - 3.64)	(1.23 - 3.33)	(2.92 - 7.89)
Connecticut	4.00***	3.18***	6.68***
	(2.82 - 5.67)	(1.92 - 5.25)	(4.07 - 10.95)
Delaware	1.64**	1.21	3.71***
	(1.16 - 2.32)	(0.73 - 1.98)	(2.26 - 6.10)
District of Columbia	3.26***	2.12*	8.37***
	(2.03 - 5.24)	(1.15 - 3.93)	(3.57 - 19.61)
Florida	8.84***	3.54***	44.30***
	(6.25 - 12.50)	(2.16 - 5.81)	(26.75 - 73.39)
Hawaii	4.79***	4.50***	4.70***
	(3.06 - 7.49)	(2.49 - 8.14)	(2.05 - 10.79)
Idaho	1.99***	1.97*	2.34
	(1.35 - 2.94)	(1.16 - 3.34)	(0.80 - 6.80)
Illinois	1.03	0.96	1.59
	(0.73 - 1.46)	(0.58 - 1.57)	(0.97 - 2.60)
Indiana	0.65*	0.63	0.47*
	(0.46 - 0.93)	(0.38 - 1.04)	(0.25 - 0.86)
Iowa	1.2	1.11	0.46*
	(0.84 - 1.73)	(0.67 - 1.85)	(0.23 - 0.94)
Kansas	1.56*	1.42	
	(1.09 - 2.25)	(0.86 - 2.35)	
Kentucky	13.36***	12.08***	16.53***
	(9.50 - 18.80)	(7.40 - 19.73)	(10.15 - 26.93)

Louisiana	1.35 (0.94 - 1.94)	1.11 (0.67 - 1.84)	6.91*** (3.21 - 14.87)
Maine	0.88 (0.62 - 1.24)	0.78 (0.47 - 1.30)	1.08 (0.66 - 1.76)
Maryland	1.37 (0.97 - 1.93)	1.35 (0.82 - 2.22)	2.15** (1.32 - 3.53)
Massachusetts	1.17 (0.83 - 1.67)	1.08 (0.65 - 1.78)	1.46 (0.87 - 2.44)
Michigan	1.38 (0.98 - 1.94)	1.13 (0.69 - 1.84)	2.28*** (1.40 - 3.71)
Mississippi	1.52* (1.05 - 2.19)	1.55 (0.93 - 2.59)	0.31* (0.09 - 1.00)
Missouri	2.00*** (1.40 - 2.86)	2.26** (1.36 - 3.75)	1.77* (1.05 - 2.99)
Montana	1.67** (1.15 - 2.42)	1.5 (0.90 - 2.50)	
Nebraska	4.65*** (2.91 - 7.43)	4.19*** (2.31 - 7.61)	8.92*** (2.92 - 27.19)
Nevada	2.30* (1.13 - 4.69)	2.75 (0.88 - 8.58)	2.65* (1.02 - 6.89)
New Hampshire	6.20*** (4.27 - 9.01)	5.28*** (3.15 - 8.84)	7.00*** (3.46 - 14.16)
New Jersey	1.09 (0.78 - 1.54)	1.74* (1.06 - 2.86)	1.22 (0.75 - 1.99)
New Mexico	8.31*** (4.06 - 17.04)	1.79 (0.44 - 7.32)	19.34*** (7.98 - 46.84)
New York	0.84 (0.59 - 1.18)	0.77 (0.47 - 1.26)	1.19 (0.73 - 1.93)
North Carolina	4.50*** (3.21 - 6.32)	3.84*** (2.36 - 6.26)	12.70*** (7.85 - 20.55)
North Dakota	2.30* (1.17 - 4.52)	1.92 (0.90 - 4.11)	
Ohio	0.89 (0.63 - 1.26)	0.91 (0.56 - 1.49)	0.68 (0.42 - 1.12)
Oklahoma	1.38 (0.97 - 1.98)	1.33 (0.80 - 2.19)	
Pennsylvania	1.18 (0.82 - 1.69)	1.28 (0.77 - 2.13)	0.77 (0.44 - 1.36)
Rhode Island	1.75** (1.24 - 2.49)	1.41 (0.85 - 2.35)	2.64*** (1.61 - 4.32)
South Carolina	1.58* (1.11 - 2.25)	1.5 (0.91 - 2.47)	1.36 (0.74 - 2.51)

South Dakota	2.40*** (1.48 - 3.88)	2.26** (1.24 - 4.15)	3.17 (0.90 - 11.18)
Tennessee	0.77 (0.53 - 1.10)	0.74 (0.45 - 1.23)	
Utah	2.06*** (1.45 - 2.92)	2.08** (1.26 - 3.42)	1.88* (1.13 - 3.13)
Washington	1.98*** (1.40 - 2.79)	1.74* (1.06 - 2.85)	3.15*** (1.93 - 5.15)
Wyoming	2.14** (1.28 - 3.58)	2.11* (1.13 - 3.95)	1.7 (0.15 - 19.85)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B10. Sensitivity with added covariates for the DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,268	164,418	60,847
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Treat			
Expansion states	2.02*** (1.43 - 2.85)	1.79* (1.09 - 2.93)	3.18*** (1.94 - 5.19)
Expansion			
After the ACA implementation (2014)	1.53*** (1.34 - 1.74)	1.28** (1.10 - 1.49)	2.87*** (2.18 - 3.78)
Medicaid expansion			
Expansion	0.83*** (0.79 - 0.86)	1.02 (0.97 - 1.07)	0.47*** (0.42 - 0.52)
MAT (No= ref)			
Yes	0.87*** (0.85 - 0.89)		
Referral sources			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.14*** (1.08 - 1.21)
Institutional referral	1.31*** (1.27 - 1.35)	1.32*** (1.28 - 1.37)	1.16*** (1.08 - 1.26)
Court/criminal justice	2.05*** (2.00 - 2.11)	2.03*** (1.97 - 2.09)	1.89*** (1.73 - 2.07)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.72 - 0.77)	0.77*** (0.75 - 0.79)	0.70*** (0.65 - 0.76)
Daily use	0.79*** (0.77 - 0.81)	0.88*** (0.85 - 0.90)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.09)
45-64	1.14*** (1.11 - 1.17)	1.23*** (1.18 - 1.27)	0.99 (0.94 - 1.05)
Gender (Female=ref)			
Male	0.93*** (0.91 - 0.95)	0.96*** (0.94 - 0.98)	0.81*** (0.78 - 0.84)

Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.82*** (0.79 - 0.85)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.88)	0.92*** (0.88 - 0.97)	0.80*** (0.75 - 0.86)
Other	0.74*** (0.70 - 0.78)	0.78*** (0.73 - 0.83)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.16*** (1.11 - 1.21)	1.20*** (1.14 - 1.26)	1.03 (0.94 - 1.14)
2 or more	0.83*** (0.77 - 0.90)	0.88** (0.80 - 0.97)	1.03 (0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.04 - 1.09)	0.97 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.87 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 1.00)
Homeless (No= ref)			
Yes	1.11*** (1.06 - 1.16)	1.15*** (1.09 - 1.21)	1.03 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.13*** (1.10 - 1.15)	1.14*** (1.11 - 1.17)	1.02 (0.98 - 1.07)
Two or more	1.22*** (1.19 - 1.25)	1.22*** (1.19 - 1.26)	1.07* (1.01 - 1.13)
Unemployment rate			
Unemployment rate	1.00 (0.98 - 1.02)	0.98 (0.96 - 1.01)	1.06** (1.02 - 1.11)
PMDP (No= ref)			
Yes	1.13*** (1.07 - 1.20)	1.17*** (1.08 - 1.26)	1.18** (1.06 - 1.32)
Year			
2011	0.99 (0.95 - 1.04)	1 (0.95 - 1.05)	0.96 (0.87 - 1.05)
2012	0.98 (0.93 - 1.03)	0.99 (0.94 - 1.05)	0.99 (0.89 - 1.11)
2013	0.89*** (0.84 - 0.95)	0.91** (0.84 - 0.97)	0.89 (0.78 - 1.03)
2014	0.62*** (0.59 - 0.66)	0.63*** (0.59 - 0.67)	0.64*** (0.57 - 0.72)

2015	0.62*** (0.59 - 0.64)	0.63*** (0.60 - 0.67)	0.62*** (0.57 - 0.67)
2016	0.71*** (0.68 - 0.74)	0.74*** (0.71 - 0.78)	0.74*** (0.69 - 0.80)
2017	-	-	-
State			
Arizona	0.32*** (0.30 - 0.35)	0.28*** (0.25 - 0.30)	0.46*** (0.40 - 0.53)
Arkansas	0.98 (0.84 - 1.13)	1.31** (1.07 - 1.60)	0.68*** (0.55 - 0.85)
Colorado	1.32*** (1.21 - 1.45)	1.19** (1.05 - 1.33)	1.53*** (1.33 - 1.77)
Connecticut	2.01*** (1.83 - 2.21)	1.81*** (1.58 - 2.07)	2.12*** (1.85 - 2.42)
Delaware	0.85*** (0.78 - 0.92)	0.71*** (0.63 - 0.79)	1.19* (1.03 - 1.36)
District of Columbia	1.63** (1.17 - 2.28)	1.19 (0.82 - 1.75)	2.66** (1.31 - 5.40)
Florida	8.92*** (6.31 - 12.61)	3.59*** (2.19 - 5.89)	44.38*** (26.78 - 73.55)
Hawaii	2.50*** (1.86 - 3.36)	2.67*** (1.90 - 3.75)	1.51 (0.77 - 2.98)
Idaho	2.06*** (1.40 - 3.04)	2.04** (1.21 - 3.46)	2.36 (0.81 - 6.86)
Illinois	0.51*** (0.48 - 0.55)	0.54*** (0.49 - 0.59)	0.50*** (0.44 - 0.57)
Iowa	0.63*** (0.56 - 0.72)	0.67*** (0.58 - 0.77)	0.15*** (0.09 - 0.25)
Kansas	1.65** (1.15 - 2.37)	1.51 (0.91 - 2.50)	
Kentucky	6.74*** (6.34 - 7.18)	6.89*** (6.37 - 7.46)	5.21*** (4.66 - 5.82)
Maine	0.91 (0.64 - 1.28)	0.82 (0.49 - 1.35)	1.09 (0.67 - 1.78)
Maryland	0.71*** (0.66 - 0.77)	0.81*** (0.73 - 0.89)	0.69*** (0.61 - 0.78)
Massachusetts	0.60*** (0.54 - 0.66)	0.62*** (0.55 - 0.70)	0.47*** (0.38 - 0.56)
Michigan	0.68*** (0.64 - 0.73)	0.63*** (0.57 - 0.69)	0.72*** (0.64 - 0.81)
Mississippi	1.50* (1.04 - 2.17)	1.52 (0.92 - 2.53)	0.30* (0.09 - 0.99)
Missouri	2.10*** (1.47 - 2.99)	2.42*** (1.46 - 4.01)	1.81* (1.07 - 3.05)
Nebraska	5.00***	4.55***	9.19***

	(3.13 - 7.98)	(2.50 - 8.25)	(3.01 - 28.07)
Nevada	1.14	1.53	0.83
	(0.61 - 2.13)	(0.55 - 4.28)	(0.36 - 1.91)
New Hampshire	3.28***	3.18***	2.25**
	(2.80 - 3.84)	(2.68 - 3.78)	(1.34 - 3.77)
New Jersey	0.55***	1	0.39***
	(0.51 - 0.59)	(0.90 - 1.11)	(0.35 - 0.43)
New Mexico	4.24***	1.01	6.17***
	(2.25 - 8.01)	(0.27 - 3.81)	(2.93 - 13.01)
New York	0.42***	0.44***	0.38***
	(0.40 - 0.45)	(0.41 - 0.48)	(0.34 - 0.42)
North Carolina	4.52***	3.84***	12.71***
	(3.22 - 6.35)	(2.36 - 6.26)	(7.85 - 20.56)
North Dakota	1.26	1.21	
	(0.71 - 2.26)	(0.67 - 2.17)	
Ohio	0.45***	0.52***	0.22***
	(0.42 - 0.48)	(0.48 - 0.57)	(0.19 - 0.25)
Oklahoma	1.44*	1.39	
	(1.00 - 2.06)	(0.84 - 2.29)	
Rhode Island	0.87**	0.79**	0.83**
	(0.78 - 0.96)	(0.67 - 0.93)	(0.72 - 0.96)
South Carolina	1.60**	1.51	1.35
	(1.12 - 2.27)	(0.92 - 2.49)	(0.73 - 2.50)
South Dakota	2.57***	2.47**	3.22
	(1.59 - 4.17)	(1.35 - 4.53)	(0.91 - 11.35)
Tennessee	0.78	0.75	
	(0.54 - 1.12)	(0.45 - 1.24)	
Utah	2.16***	2.20**	1.91*
	(1.52 - 3.06)	(1.34 - 3.62)	(1.15 - 3.18)
Washington	-	-	-
Wyoming	2.17**	2.14*	1.7
	(1.30 - 3.63)	(1.14 - 4.01)	(0.15 - 19.91)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B11. Sensitivity with lagged model for the DID model for the adjusted association between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	225,272	164,420	60,849
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Expansion states	2.87*** (2.03 - 4.05)	2.07** (1.25 - 3.44)	3.34*** (2.08 - 5.38)
Expansion year (2014)	2.15*** (2.02 - 2.29)	2.36*** (2.20 - 2.53)	1.59*** (1.33 - 1.91)
Expansion * Post expansion year 0	0.57*** (0.53 - 0.61)	0.57*** (0.53 - 0.62)	0.61*** (0.51 - 0.74)
Post expansion year 1	0.39*** (0.36 - 0.42)	0.36*** (0.33 - 0.40)	0.56*** (0.45 - 0.70)
Expansion* Post expansion year 1	2.48*** (2.26 - 2.73)	3.00*** (2.69 - 3.34)	1.45** (1.15 - 1.83)
Post expansion year 2	1.49*** (1.38 - 1.62)	1.57*** (1.43 - 1.72)	1.38*** (1.14 - 1.66)
Expansion* Post expansion year 2	0.62*** (0.57 - 0.68)	0.59*** (0.53 - 0.65)	0.72** (0.59 - 0.88)
Post expansion year 3	0.70*** (0.66 - 0.74)	0.99 (0.93 - 1.07)	0.25*** (0.21 - 0.29)
Expansion* Post expansion year 3	1.29*** (1.20 - 1.40)	0.93 (0.85 - 1.02)	3.58*** (3.04 - 4.23)
MAT (No= ref)			
Yes	2.23*** (2.17 - 2.28)		
Referral sources			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.98 - 1.05)	0.88*** (0.83 - 0.93)
Institutional referral	1.05** (1.01 - 1.08)	1.22*** (1.17 - 1.26)	0.79*** (0.73 - 0.85)
Court/criminal justice	1.88*** (1.83 - 1.93)	2.17*** (2.11 - 2.23)	0.73*** (0.68 - 0.80)
Frequency of use (No past month use= ref)			
Some use	0.71*** (0.69 - 0.74)	0.70*** (0.68 - 0.72)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.86*** (0.81 - 0.91)
Age (18-29= ref)			
30-44	1.07***	1.07***	1.09***

	(1.05 - 1.09)	(1.05 - 1.10)	(1.04 - 1.13)
45-64	1.30***	1.32***	1.30***
	(1.27 - 1.34)	(1.27 - 1.36)	(1.23 - 1.37)
Gender (Female=ref)			
Male	0.90***	0.89***	0.93***
	(0.88 - 0.92)	(0.87 - 0.91)	(0.90 - 0.96)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94**	0.94*	0.94*
	(0.91 - 0.98)	(0.89 - 0.99)	(0.88 - 1.00)
Hispanic	1.01	0.94**	1.09**
	(0.97 - 1.05)	(0.89 - 0.98)	(1.02 - 1.16)
Other	1.00	1.00	0.98
	(0.95 - 1.06)	(0.94 - 1.07)	(0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98	1.00	0.96*
	(0.96 - 1.00)	(0.98 - 1.03)	(0.92 - 1.00)
Number of arrests (0= ref)			
1	0.96	1.04	0.79***
	(0.92 - 1.00)	(0.99 - 1.09)	(0.72 - 0.86)
2 or more	1.20***	1.17***	0.89
	(1.11 - 1.30)	(1.07 - 1.28)	(0.73 - 1.07)
Employment status (Unemployed= ref)			
Employed	0.80***	0.79***	0.84***
	(0.78 - 0.82)	(0.77 - 0.81)	(0.80 - 0.87)
Comorbidity (No= ref)			
Yes	0.88***	0.89***	0.89***
	(0.86 - 0.90)	(0.87 - 0.92)	(0.85 - 0.92)
Homeless (No= ref)			
Yes	0.73***	0.77***	0.70***
	(0.70 - 0.76)	(0.72 - 0.81)	(0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.79***	0.79***	0.85***
	(0.78 - 0.81)	(0.77 - 0.82)	(0.82 - 0.89)
Two or more	0.73***	0.76***	0.76***
	(0.71 - 0.75)	(0.73 - 0.78)	(0.72 - 0.80)
Year			
2011	1.18***	1.23***	1.09*
	(1.14 - 1.23)	(1.18 - 1.29)	(1.01 - 1.17)
2012	1.16***	1.23***	1.06
	(1.11 - 1.20)	(1.17 - 1.29)	(0.98 - 1.14)
2013	1.19***	1.27***	1.05
	(1.14 - 1.23)	(1.21 - 1.33)	(0.97 - 1.14)
State			
Arizona	1.75***	2.09***	1.30***

Arkansas	(1.63 - 1.88) 0.39*** (0.34 - 0.45)	(1.92 - 2.28) 0.50*** (0.41 - 0.62)	(1.12 - 1.50) 0.30*** (0.24 - 0.37)
Colorado	0.80*** (0.74 - 0.88)	0.87* (0.77 - 0.97)	0.65*** (0.56 - 0.74)
Connecticut	0.51*** (0.47 - 0.56)	0.33*** (0.29 - 0.37)	0.67*** (0.58 - 0.76)
Delaware	0.53*** (0.48 - 0.57)	0.70*** (0.63 - 0.78)	0.29*** (0.25 - 0.33)
District of Columbia	1.57* (1.10 - 2.26)	1.76** (1.18 - 2.63)	1.24 (0.54 - 2.88)
Florida	1.67** (1.18 - 2.36)	1.04 (0.62 - 1.72)	1.91** (1.19 - 3.07)
Hawaii	0.28*** (0.21 - 0.37)	0.19*** (0.13 - 0.26)	1.7 (0.70 - 4.13)
Idaho	2.59*** (1.76 - 3.83)	1.98* (1.15 - 3.39)	1.86 (0.64 - 5.38)
Illinois	0.43*** (0.40 - 0.47)	0.49*** (0.44 - 0.54)	0.35*** (0.31 - 0.40)
Iowa	0.76*** (0.68 - 0.85)	0.84** (0.74 - 0.95)	0.67* (0.49 - 0.92)
Kansas	3.35*** (2.34 - 4.81)	2.70*** (1.61 - 4.53)	
Kentucky	0.06*** (0.05 - 0.06)	0.06*** (0.06 - 0.07)	0.07*** (0.06 - 0.07)
Maine	2.26*** (1.60 - 3.19)	1.61 (0.96 - 2.69)	2.26*** (1.41 - 3.62)
Maryland	0.60*** (0.56 - 0.65)	0.69*** (0.63 - 0.77)	0.44*** (0.40 - 0.49)
Massachusetts	0.74*** (0.67 - 0.82)	0.89 (0.79 - 1.00)	0.56*** (0.47 - 0.66)
Michigan	0.49*** (0.45 - 0.52)	0.50*** (0.46 - 0.55)	0.48*** (0.43 - 0.54)
Mississippi	1.23 (0.85 - 1.79)	0.91 (0.54 - 1.53)	1.61 (0.62 - 4.18)
Missouri	1.68** (1.18 - 2.39)	1.12 (0.67 - 1.88)	2.57*** (1.56 - 4.26)
Nebraska	1 (0.64 - 1.56)	0.84 (0.47 - 1.52)	0.67 (0.24 - 1.86)
Nevada	1.07 (0.55 - 2.06)	0.65 (0.23 - 1.82)	1.62 (0.60 - 4.40)
New Hampshire	0.42*** (0.36 - 0.48)	0.42*** (0.36 - 0.49)	0.63 (0.38 - 1.03)
New Jersey	0.64*** (0.59 - 0.68)	0.57*** (0.51 - 0.63)	0.54*** (0.49 - 0.60)
New Mexico	0.36***	0.09*	0.31***

New York	(0.21 - 0.63) 0.67***	(0.01 - 0.75) 0.77***	(0.17 - 0.56) 0.55***
North Carolina	(0.63 - 0.71) 0.57**	(0.71 - 0.83) 0.48**	(0.50 - 0.61) 0.65
North Dakota	(0.41 - 0.81) 0.84	(0.29 - 0.79) 0.95	(0.41 - 1.04)
Ohio	(0.47 - 1.48) 0.74***	(0.53 - 1.69) 0.86***	0.58***
Oklahoma	(0.70 - 0.80) 4.69***	(0.79 - 0.94) 3.62***	(0.52 - 0.66)
Rhode Island	(3.28 - 6.72) 0.87**	(2.16 - 6.06) 0.60***	0.91
South Carolina	(0.79 - 0.97) 2.01***	(0.51 - 0.70) 1.74*	(0.79 - 1.05) 1.47
South Dakota	(1.41 - 2.86) 1.58	(1.04 - 2.91) 1.32	(0.80 - 2.73) 1.07
Tennessee	(0.98 - 2.53) 1.47*	(0.72 - 2.43) 1.15	(0.31 - 3.69) 0.91
Utah	(1.03 - 2.11) 2.74***	(0.68 - 1.92) 2.55***	(0.08 - 10.64) 1.62
Washington	(1.94 - 3.87) -	(1.54 - 4.24) -	(0.99 - 2.63) -
Wyoming	3.21*** (1.91 - 5.41)	2.48** (1.30 - 4.71)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B12. Sensitivity with lagged model for the DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	223,557	163,159	60,395
	AOR	AOR	AOR
	(95%CI)	(95%CI)	(95%CI)
Expansion states	2.15*** (1.52 - 3.06)	1.91* (1.16 - 3.15)	3.10*** (1.87 - 5.13)
Expansion year (2014)	0.61*** (0.57 - 0.65)	0.64*** (0.60 - 0.68)	0.50*** (0.41 - 0.61)
Expansion * Post expansion year 0	1.61*** (1.51 - 1.73)	1.64*** (1.52 - 1.76)	1.78*** (1.45 - 2.19)
Post expansion year 1	1.29*** (1.19 - 1.39)	1.23*** (1.13 - 1.33)	2.14*** (1.67 - 2.74)
Expansion* Post expansion year 1	0.68*** (0.62 - 0.75)	0.75*** (0.68 - 0.83)	0.36*** (0.28 - 0.47)
Post expansion year 2	1.47*** (1.36 - 1.58)	1.47*** (1.36 - 1.60)	1.45** (1.16 - 1.81)
Expansion* Post expansion year 2	0.72*** (0.66 - 0.79)	0.72*** (0.65 - 0.79)	0.78* (0.61 - 0.99)
Post expansion year 3	1.93*** (1.81 - 2.05)	1.56*** (1.46 - 1.67)	2.15*** (1.80 - 2.57)
Expansion* Post expansion year 3	0.59*** (0.54 - 0.64)	0.74*** (0.67 - 0.81)	0.54*** (0.44 - 0.65)
MAT (No= ref)			
Yes	0.87*** (0.85 - 0.89)		
Referral sources			
Healthcare provider referral	1.08*** (1.05 - 1.11)	1.06*** (1.03 - 1.10)	1.15*** (1.08 - 1.22)
Institutional referral	1.32*** (1.28 - 1.37)	1.34*** (1.29 - 1.39)	1.18*** (1.09 - 1.27)
Court/criminal justice	2.08*** (2.02 - 2.13)	2.04*** (1.98 - 2.10)	1.91*** (1.75 - 2.09)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.72 - 0.77)	0.77*** (0.74 - 0.79)	0.70*** (0.65 - 0.75)
Daily use	0.78***	0.87***	0.58***

	(0.76 - 0.80)	(0.84 - 0.89)	(0.54 - 0.61)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.10)	1.04 (0.99 - 1.09)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	1.00 (0.94 - 1.06)
Gender (Female=ref)			
Male	0.92*** (0.91 - 0.94)	0.96** (0.94 - 0.98)	0.80*** (0.77 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.82*** (0.78 - 0.85)	0.93** (0.89 - 0.98)	0.67*** (0.62 - 0.72)
Hispanic	0.85*** (0.82 - 0.89)	0.92** (0.88 - 0.97)	0.80*** (0.74 - 0.85)
Other	0.76*** (0.72 - 0.80)	0.79*** (0.74 - 0.84)	0.68*** (0.60 - 0.77)
Education (Less than high school= ref)			
Highschool or higher	1.18*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.20*** (1.14 - 1.26)	1.03 (0.94 - 1.14)
2 or more	0.83*** (0.77 - 0.90)	0.88** (0.81 - 0.97)	1.04 (0.84 - 1.30)
Employment status (Unemployed= ref)			
Employed	1.03* (1.00 - 1.05)	1.06*** (1.03 - 1.09)	0.97 (0.92 - 1.01)
Comorbidity (No= ref)			
Yes	0.90*** (0.88 - 0.92)	0.87*** (0.85 - 0.89)	0.96 (0.92 - 1.00)
Homeless (No= ref)			
Yes	1.10*** (1.05 - 1.15)	1.14*** (1.08 - 1.21)	1.01 (0.93 - 1.10)
Polysubstance use (no= ref)			
One more	1.11*** (1.08 - 1.13)	1.13*** (1.10 - 1.16)	1.02 (0.98 - 1.07)
Two or more	1.20*** (1.17 - 1.23)	1.21*** (1.17 - 1.24)	1.07* (1.01 - 1.13)
Year			
2011	1.01 (0.97 - 1.05)	1.03 (0.99 - 1.08)	0.96 (0.88 - 1.04)
2012	1 (0.96 - 1.04)	1.04 (0.99 - 1.08)	0.96 (0.88 - 1.05)
2013	0.92***	0.96	0.86***

State	(0.89 - 0.96)	(0.92 - 1.01)	(0.78 - 0.93)
Arizona	0.35*** (0.32 - 0.37)	0.30*** (0.27 - 0.32)	0.51*** (0.45 - 0.59)
Arkansas	1 (0.87 - 1.15)	1.32** (1.08 - 1.61)	0.66*** (0.53 - 0.82)
Colorado	1.41*** (1.29 - 1.53)	1.29*** (1.15 - 1.44)	1.52*** (1.33 - 1.73)
Connecticut	2.22*** (2.02 - 2.44)	1.97*** (1.72 - 2.25)	2.33*** (2.04 - 2.67)
Delaware	0.87*** (0.80 - 0.94)	0.73*** (0.65 - 0.81)	1.12 (0.98 - 1.28)
District of Columbia	1.63** (1.17 - 2.27)	1.19 (0.81 - 1.73)	2.61** (1.29 - 5.26)
Florida	9.71*** (6.83 - 13.80)	3.75*** (2.28 - 6.18)	48.02*** (28.64 - 80.51)
Hawaii	2.63*** (1.97 - 3.52)	2.94*** (2.10 - 4.11)	1.35 (0.69 - 2.65)
Idaho	2.42*** (1.63 - 3.59)	2.36** (1.39 - 4.01)	2.43 (0.83 - 7.09)
Illinois	0.56*** (0.52 - 0.61)	0.58*** (0.52 - 0.64)	0.57*** (0.50 - 0.64)
Iowa	0.68*** (0.60 - 0.76)	0.74*** (0.65 - 0.83)	0.15*** (0.09 - 0.25)
Kansas	1.72** (1.19 - 2.48)	1.62 (0.97 - 2.68)	
Kentucky	7.09*** (6.67 - 7.55)	7.21*** (6.67 - 7.80)	5.66*** (5.07 - 6.32)
Maine	1.06 (0.74 - 1.50)	0.94 (0.57 - 1.57)	1.19 (0.72 - 1.97)
Maryland	0.69*** (0.64 - 0.74)	0.78*** (0.70 - 0.85)	0.61*** (0.55 - 0.68)
Massachusetts	0.63*** (0.57 - 0.70)	0.66*** (0.58 - 0.74)	0.47*** (0.39 - 0.56)
Michigan	0.73*** (0.68 - 0.78)	0.65*** (0.60 - 0.71)	0.81*** (0.73 - 0.91)
Mississippi	1.50* (1.03 - 2.19)	1.52 (0.91 - 2.54)	0.31 (0.09 - 1.04)
Missouri	2.17*** (1.51 - 3.10)	2.37*** (1.43 - 3.93)	1.74* (1.02 - 2.95)
Nebraska	5.93*** (3.71 - 9.47)	5.42*** (2.99 - 9.83)	8.32*** (2.74 - 25.25)
Nevada	1.18 (0.64 - 2.21)	1.71 (0.61 - 4.78)	0.9 (0.39 - 2.07)
New Hampshire	3.39*** (2.91 - 3.95)	3.39*** (2.88 - 4.00)	1.96** (1.18 - 3.26)

New Jersey	0.60*** (0.55 - 0.64)	1.06 (0.95 - 1.18)	0.42*** (0.38 - 0.47)
New Mexico	4.61*** (2.44 - 8.68)	1.11 (0.29 - 4.19)	6.40*** (3.04 - 13.46)
New York	0.45*** (0.42 - 0.47)	0.46*** (0.43 - 0.50)	0.40*** (0.36 - 0.44)
North Carolina	5.05*** (3.57 - 7.14)	4.27*** (2.61 - 6.98)	11.96*** (7.29 - 19.63)
North Dakota	1.32 (0.75 - 2.35)	1.36 (0.77 - 2.42)	
Ohio	0.47*** (0.44 - 0.50)	0.55*** (0.50 - 0.60)	0.22*** (0.19 - 0.25)
Oklahoma	1.63** (1.13 - 2.34)	1.58 (0.95 - 2.61)	
Rhode Island	0.93 (0.84 - 1.02)	0.81* (0.69 - 0.95)	0.95 (0.83 - 1.08)
South Carolina	1.78** (1.25 - 2.55)	1.67* (1.01 - 2.77)	1.18 (0.63 - 2.21)
South Dakota	3.00*** (1.85 - 4.87)	2.91*** (1.59 - 5.34)	2.98 (0.83 - 10.69)
Tennessee	0.89 (0.62 - 1.29)	0.84 (0.51 - 1.40)	
Utah	2.56*** (1.80 - 3.64)	2.63*** (1.60 - 4.34)	1.86* (1.11 - 3.11)
Washington	-	-	-
Wyoming	2.36** (1.40 - 3.99)	2.31** (1.23 - 4.34)	1.13 (0.10 - 13.26)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B13. Sensitivity analysis added Waiver 1115 Demonstrations: 2WFE model for the adjusted associations between Medicaid expansion and treatment length of stay

	2 ways fixed effect pooled model	Non-MAT	MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.93** (0.90 - 0.98)	0.93** (0.89 - 0.98)	1.15** (1.05 - 1.27)
Waiver 1115 Demonstration			
Yes	0.93 (0.85 - 1.02)	0.75*** (0.65 - 0.87)	1.29*** (1.14 - 1.46)
MAT (No= ref)			
Yes	2.21*** (2.16 - 2.27)		
Referral sources (Self- referral= ref)			
Healthcare provider referral	0.93*** (0.90 - 0.96)	1.01 (0.97 - 1.04)	0.87*** (0.83 - 0.92)
Institutional referral	1.04* (1.01 - 1.08)	1.21*** (1.17 - 1.26)	0.78*** (0.72 - 0.84)
Court/criminal justice	1.87*** (1.82 - 1.92)	2.14*** (2.08 - 2.20)	0.74*** (0.69 - 0.81)
Frequency of use (No past month use= ref)			
Some use	0.72*** (0.70 - 0.74)	0.70*** (0.68 - 0.73)	0.85*** (0.79 - 0.91)
Daily use	0.67*** (0.66 - 0.69)	0.62*** (0.60 - 0.64)	0.84*** (0.80 - 0.89)
Age (18-29= ref)			
30-44	1.07*** (1.05 - 1.09)	1.07*** (1.04 - 1.10)	1.09*** (1.04 - 1.13)
45-64	1.31*** (1.27 - 1.34)	1.32*** (1.27 - 1.36)	1.31*** (1.24 - 1.38)
Gender (Female=ref)			

Male	0.90*** (0.88 - 0.91)	0.89*** (0.87 - 0.91)	0.92*** (0.89 - 0.95)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94** (0.91 - 0.98)	0.94** (0.89 - 0.98)	0.92* (0.87 - 0.98)
Hispanic	1.01 (0.98 - 1.05)	0.94* (0.90 - 0.99)	1.09** (1.02 - 1.15)
Other	1.00 (0.95 - 1.06)	1.00 (0.94 - 1.06)	0.98 (0.88 - 1.10)
Education (Less than high school= ref)			
Highschool or higher	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.03)	0.96* (0.92 - 0.99)
Number of arrests (0= ref)			
1	0.97 (0.93 - 1.01)	1.04 (0.99 - 1.09)	0.79*** (0.73 - 0.86)
2 or more	1.18*** (1.09 - 1.28)	1.16*** (1.06 - 1.27)	0.88 (0.73 - 1.06)
Employment status (Unemployed= ref)			
Employed	0.79*** (0.77 - 0.81)	0.78*** (0.76 - 0.80)	0.83*** (0.80 - 0.86)
Comorbidity (No= ref)			
Yes	0.88*** (0.86 - 0.90)	0.90*** (0.87 - 0.92)	0.89*** (0.85 - 0.92)
Homeless (No= ref)			
Yes	0.74*** (0.70 - 0.77)	0.77*** (0.73 - 0.81)	0.70*** (0.65 - 0.76)
Polysubstance use (no= ref)			
One more	0.79*** (0.78 - 0.81)	0.80*** (0.78 - 0.82)	0.86*** (0.82 - 0.89)
Two or more	0.73*** (0.71 - 0.74)	0.76*** (0.73 - 0.78)	0.76*** (0.72 - 0.80)
Year			
2011	1.16*** (1.12 - 1.21)	1.21*** (1.16 - 1.27)	1.07 (1.00 - 1.16)
2012	1.15*** (1.10 - 1.19)	1.22*** (1.17 - 1.28)	1.02 (0.95 - 1.11)
2013	1.18*** (1.14 - 1.23)	1.26*** (1.21 - 1.32)	1.02 (0.94 - 1.11)
2014	1.48***	1.68***	0.89*

	(1.41 - 1.55)	(1.59 - 1.77)	(0.80 - 0.99)
2015	1.15***	1.36***	0.68***
	(1.09 - 1.21)	(1.28 - 1.44)	(0.61 - 0.75)
2016	1.19***	1.41***	0.70***
	(1.13 - 1.25)	(1.33 - 1.49)	(0.63 - 0.78)
2017	0.98	1.34***	0.50***
	(0.93 - 1.03)	(1.27 - 1.41)	(0.45 - 0.55)
State			
Alaska	4.20***	3.40***	3.15***
	(2.86 - 6.17)	(1.98 - 5.83)	(1.68 - 5.91)
Arizona	5.21***	4.45***	4.53***
	(3.71 - 7.33)	(2.69 - 7.36)	(2.84 - 7.22)
Arkansas	1.21	1.24	0.85
	(0.84 - 1.75)	(0.72 - 2.13)	(0.52 - 1.39)
Colorado	2.37***	1.82*	2.22***
	(1.68 - 3.34)	(1.09 - 3.02)	(1.40 - 3.53)
Connecticut	1.55*	0.72	2.34***
	(1.10 - 2.19)	(0.43 - 1.20)	(1.47 - 3.72)
Delaware	1.67**	1.99*	0.75
	(1.17 - 2.39)	(1.17 - 3.37)	(0.47 - 1.22)
District of Columbia	4.65***	3.72***	4.26**
	(2.85 - 7.59)	(1.97 - 7.04)	(1.65 - 11.01)
Florida	1.65**	0.99	2.01**
	(1.17 - 2.32)	(0.60 - 1.65)	(1.28 - 3.18)
Hawaii	0.82	0.40**	5.74***
	(0.53 - 1.27)	(0.22 - 0.73)	(2.13 - 15.48)
Idaho	2.56***	1.88*	1.9
	(1.74 - 3.76)	(1.10 - 3.22)	(0.66 - 5.46)
Illinois	1.29	1.03	1.23
	(0.92 - 1.82)	(0.62 - 1.71)	(0.78 - 1.95)
Indiana	1.89***	1.57	1.74*
	(1.33 - 2.67)	(0.94 - 2.61)	(1.04 - 2.91)
Iowa	2.22***	1.77*	2.39**
	(1.56 - 3.16)	(1.06 - 2.95)	(1.39 - 4.13)
Kansas	3.37***	2.70***	
	(2.35 - 4.82)	(1.61 - 4.52)	
Kentucky	0.17***	0.13***	0.23***
	(0.12 - 0.24)	(0.08 - 0.21)	(0.14 - 0.36)
Louisiana	2.18***	1.97*	0.55
	(1.52 - 3.13)	(1.17 - 3.31)	(0.26 - 1.15)
Maine	2.30***	1.59	2.51***
	(1.63 - 3.24)	(0.95 - 2.65)	(1.59 - 3.95)

Maryland	1.87*** (1.32 - 2.67)	1.91* (1.13 - 3.23)	1.15 (0.72 - 1.84)
Massachusetts	2.33*** (1.63 - 3.33)	2.49*** (1.47 - 4.24)	1.5 (0.92 - 2.44)
Michigan	1.44* (1.02 - 2.02)	1.06 (0.64 - 1.75)	1.67* (1.06 - 2.64)
Mississippi	1.16 (0.80 - 1.67)	0.83 (0.49 - 1.40)	1.95 (0.78 - 4.88)
Missouri	1.67** (1.18 - 2.37)	1.1 (0.66 - 1.84)	2.87*** (1.76 - 4.66)
Montana	2.14*** (1.48 - 3.08)	1.70* (1.01 - 2.87)	
Nebraska	1.02 (0.66 - 1.58)	0.83 (0.46 - 1.48)	0.73 (0.27 - 2.01)
Nevada	3.19** (1.52 - 6.69)	1.44 (0.46 - 4.48)	5.49** (1.83 - 16.41)
New Hampshire	1.24 (0.86 - 1.77)	0.9 (0.54 - 1.51)	2.12* (1.09 - 4.13)
New Jersey	2.00*** (1.42 - 2.83)	1.52 (0.90 - 2.55)	1.56 (0.98 - 2.48)
New Mexico	1.09 (0.57 - 2.09)	0.2 (0.02 - 1.76)	1.04 (0.49 - 2.21)
New York	1.95*** (1.39 - 2.73)	1.6 (0.97 - 2.65)	1.89** (1.20 - 2.97)
North Carolina	0.59** (0.42 - 0.83)	0.50** (0.30 - 0.82)	0.54** (0.35 - 0.85)
North Dakota	2.46** (1.27 - 4.75)	1.99 (0.93 - 4.26)	
Ohio	2.19*** (1.56 - 3.07)	1.82* (1.10 - 3.01)	1.95** (1.24 - 3.09)
Oklahoma	4.69*** (3.29 - 6.71)	3.53*** (2.11 - 5.89)	
Pennsylvania	1.17 (0.82 - 1.69)	0.95 (0.56 - 1.61)	1.11 (0.67 - 1.86)
Rhode Island	2.78*** (1.94 - 3.99)	1.69 (0.99 - 2.91)	2.42*** (1.50 - 3.90)
South Carolina	2.09*** (1.47 - 2.96)	1.80* (1.08 - 3.00)	1.57 (0.87 - 2.83)
South Dakota	1.62* (1.01 - 2.60)	1.32 (0.72 - 2.41)	1.27 (0.39 - 4.18)
Tennessee	1.50* (1.05 - 2.15)	1.14 (0.68 - 1.90)	1.07 (0.09 - 12.65)

Utah	2.76*** (1.96 - 3.89)	2.50*** (1.51 - 4.15)	1.77* (1.11 - 2.84)
Washington	2.93*** (2.08 - 4.12)	2.10** (1.27 - 3.49)	3.31*** (2.09 - 5.24)
Wyoming	2.90*** (1.73 - 4.86)	2.11* (1.11 - 3.99)	

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B14. Sensitivity analysis added Waiver 1115 Demonstrations: 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	231,025	169,449	61,573
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.85*** (0.81 - 0.88)	1.02 (0.97 - 1.07)	0.49*** (0.44 - 0.54)
Waiver 1115 Demonstration			
Yes	0.84*** (0.77 - 0.92)	0.83* (0.72 - 0.96)	0.93 (0.80 - 1.07)
MAT (No= ref)			
Yes	0.86*** (0.84 - 0.88)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.07*** (1.04 - 1.10)	1.05** (1.02 - 1.09)	1.15*** (1.08 - 1.21)
Institutional referral	1.30*** (1.26 - 1.34)	1.32*** (1.27 - 1.37)	1.15*** (1.07 - 1.24)
Court/criminal justice	2.03*** (1.98 - 2.09)	2.00*** (1.94 - 2.06)	1.89*** (1.73 - 2.06)
Frequency of use (No past month use= ref)			
Some use	0.74*** (0.71 - 0.76)	0.76*** (0.73 - 0.78)	0.70*** (0.65 - 0.76)
Daily use	0.77*** (0.75 - 0.79)	0.85*** (0.83 - 0.88)	0.59*** (0.55 - 0.62)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.09)	1.07*** (1.04 - 1.09)	1.04 (0.99 - 1.09)
45-64	1.14*** (1.11 - 1.18)	1.23*** (1.19 - 1.27)	0.99 (0.93 - 1.05)
Gender (Female=ref)			

Male	0.93*** (0.92 - 0.95)	0.97** (0.95 - 0.99)	0.81*** (0.78 - 0.84)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.83*** (0.79 - 0.86)	0.94* (0.90 - 0.99)	0.68*** (0.63 - 0.73)
Hispanic	0.85*** (0.82 - 0.89)	0.92*** (0.88 - 0.97)	0.81*** (0.75 - 0.87)
Other	0.73*** (0.69 - 0.77)	0.76*** (0.72 - 0.81)	0.69*** (0.61 - 0.78)
Education (Less than high school= ref)			
Highschool or higher	1.19*** (1.16 - 1.21)	1.17*** (1.14 - 1.20)	1.20*** (1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15*** (1.10 - 1.20)	1.19*** (1.13 - 1.24)	1.04 (0.94 - 1.14)
2 or more	0.84*** (0.78 - 0.91)	0.89* (0.81 - 0.97)	1.03 (0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.03* (1.01 - 1.05)	1.06*** (1.03 - 1.09)	0.98 (0.93 - 1.02)
Comorbidity (No= ref)			
Yes	0.89*** (0.88 - 0.91)	0.87*** (0.85 - 0.89)	0.95* (0.91 - 0.99)
Homeless (No= ref)			
Yes	1.10*** (1.06 - 1.15)	1.13*** (1.08 - 1.20)	1.02 (0.94 - 1.12)
Polysubstance use (no= ref)			
One more	1.12*** (1.09 - 1.14)	1.13*** (1.11 - 1.16)	1.02 (0.98 - 1.07)
Two or more	1.21*** (1.18 - 1.25)	1.22*** (1.18 - 1.25)	1.07* (1.01 - 1.13)
Year			
2011	1.02 (0.98 - 1.06)	1.04 (0.99 - 1.08)	0.95 (0.88 - 1.04)
2012	1.01 (0.97 - 1.05)	1.04 (0.99 - 1.08)	0.97 (0.89 - 1.05)
2013	0.93*** (0.90 - 0.97)	0.97 (0.93 - 1.01)	0.87** (0.80 - 0.95)
2014	0.97	0.88***	1.56***

	(0.92 - 1.01)	(0.83 - 0.92)	(1.38 - 1.78)
2015	0.97	0.90***	1.41***
	(0.92 - 1.01)	(0.85 - 0.95)	(1.24 - 1.60)
2016	1.12***	1.06*	1.63***
	(1.06 - 1.17)	(1.01 - 1.12)	(1.44 - 1.84)
2017	1.02	1.04	0.95
	(0.98 - 1.06)	(0.99 - 1.08)	(0.88 - 1.04)
State			
Alaska	1.50*	1.53	0.94
	(1.03 - 2.20)	(0.90 - 2.58)	(0.46 - 1.91)
Arizona	0.64**	0.49**	1.44
	(0.45 - 0.90)	(0.30 - 0.80)	(0.88 - 2.36)
Arkansas	2.08***	2.45***	2.01*
	(1.44 - 3.01)	(1.44 - 4.15)	(1.18 - 3.42)
Colorado	2.65***	2.17**	4.37***
	(1.87 - 3.74)	(1.32 - 3.56)	(2.67 - 7.14)
Connecticut	3.98***	3.21***	6.49***
	(2.81 - 5.64)	(1.94 - 5.30)	(3.96 - 10.64)
Delaware	1.95***	1.48	3.53***
	(1.36 - 2.78)	(0.88 - 2.48)	(2.11 - 5.88)
District of Columbia	3.05***	1.98*	7.57***
	(1.90 - 4.89)	(1.07 - 3.66)	(3.24 - 17.65)
Florida	8.57***	3.41***	44.14***
	(6.06 - 12.11)	(2.08 - 5.60)	(26.72 - 72.93)
Hawaii	5.03***	5.01***	4.03***
	(3.22 - 7.84)	(2.78 - 9.03)	(1.77 - 9.17)
Idaho	2.06***	2.09**	2.16
	(1.39 - 3.03)	(1.24 - 3.54)	(0.74 - 6.29)
Illinois	1.03	0.96	1.59
	(0.73 - 1.45)	(0.59 - 1.57)	(0.98 - 2.60)
Indiana	0.66*	0.65	0.46*
	(0.47 - 0.94)	(0.39 - 1.07)	(0.25 - 0.84)
Iowa	1.27	1.25	0.41*
	(0.89 - 1.81)	(0.76 - 2.07)	(0.20 - 0.82)
Kansas	1.61**	1.53	
	(1.12 - 2.31)	(0.92 - 2.52)	
Kentucky	13.37***	12.28***	16.13***
	(9.50 - 18.81)	(7.52 - 20.05)	(9.91 - 26.25)
Louisiana	1.4	1.19	6.41***
	(0.97 - 2.02)	(0.72 - 1.98)	(2.99 - 13.76)
Maine	0.91	0.84	1.01
	(0.64 - 1.28)	(0.51 - 1.38)	(0.62 - 1.63)

Maryland	1.60* (1.12 - 2.28)	1.63 (0.98 - 2.73)	1.95** (1.17 - 3.23)
Massachusetts	1.43 (0.99 - 2.05)	1.37 (0.82 - 2.30)	1.44 (0.85 - 2.44)
Michigan	1.36 (0.97 - 1.92)	1.11 (0.68 - 1.82)	2.30*** (1.41 - 3.75)
Mississippi	1.50* (1.04 - 2.17)	1.52 (0.91 - 2.53)	0.32 (0.10 - 1.04)
Missouri	1.84*** (1.30 - 2.62)	2.08** (1.26 - 3.43)	1.45 (0.87 - 2.42)
Montana	1.70** (1.18 - 2.46)	1.59 (0.96 - 2.65)	
Nebraska	4.95*** (3.12 - 7.86)	4.75*** (2.63 - 8.57)	6.74*** (2.26 - 20.09)
Nevada	2.25* (1.11 - 4.58)	2.72 (0.87 - 8.47)	2.71* (1.04 - 7.04)
New Hampshire	6.33*** (4.38 - 9.15)	5.68*** (3.41 - 9.48)	5.69*** (2.84 - 11.41)
New Jersey	1.23 (0.87 - 1.74)	2.00** (1.20 - 3.32)	1.25 (0.76 - 2.05)
New Mexico	8.63*** (4.21 - 17.68)	1.81 (0.44 - 7.44)	18.20*** (7.53 - 43.97)
New York	0.85 (0.60 - 1.19)	0.8 (0.49 - 1.30)	1.14 (0.70 - 1.85)
North Carolina	4.50*** (3.21 - 6.32)	3.83*** (2.35 - 6.25)	12.86*** (7.95 - 20.79)
North Dakota	2.58** (1.33 - 5.01)	2.39* (1.13 - 5.05)	
Ohio	0.9 (0.64 - 1.27)	0.94 (0.57 - 1.53)	0.66 (0.40 - 1.08)
Oklahoma	1.44* (1.01 - 2.05)	1.43 (0.87 - 2.36)	
Pennsylvania	1.25 (0.87 - 1.80)	1.37 (0.82 - 2.28)	0.78 (0.44 - 1.38)
Rhode Island	2.06*** (1.43 - 2.95)	1.65 (0.97 - 2.80)	2.94*** (1.76 - 4.90)
South Carolina	1.58* (1.11 - 2.25)	1.5 (0.91 - 2.46)	1.35 (0.73 - 2.49)
South Dakota	2.53*** (1.57 - 4.09)	2.55** (1.40 - 4.64)	2.71 (0.78 - 9.47)
Tennessee	0.78 (0.54 - 1.11)	0.76 (0.46 - 1.25)	

Utah	2.17*** (1.54 - 3.07)	2.30*** (1.40 - 3.77)	1.68* (1.02 - 2.76)
Washington	1.98*** (1.40 - 2.79)	1.77* (1.08 - 2.90)	3.00*** (1.84 - 4.88)
Wyoming	2.16** (1.29 - 3.62)	2.16* (1.16 - 4.04)	1.68 (0.14 - 19.57)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B15. 2WFE model for the adjusted associations between Medicaid expansion and length of stay

	2 ways fixed effect pooled model	2 ways fixed effect Non-MAT	2 ways fixed effect MAT
N	518,154	326,027	192,127
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion			
Expansion	0.96* (0.93 - 1.00)	0.89*** (0.85 - 0.93)	1.11** (1.04 - 1.19)
MAT (No= ref)			
Yes	2.07*** (2.04 - 2.10)		
Referral sources			
Healthcare provider referral	0.83*** (0.82 - 0.85)	0.95*** (0.93 - 0.97)	0.79*** (0.77 - 0.81)
Institutional referral	0.99 (0.97 - 1.01)	1.15*** (1.12 - 1.18)	0.86*** (0.83 - 0.90)
Court/criminal justice	1.34*** (1.32 - 1.36)	1.60*** (1.56 - 1.63)	0.72*** (0.69 - 0.75)
Frequency of use (No past month use= ref)			
Some use	0.68*** (0.67 - 0.69)	0.64*** (0.63 - 0.65)	0.80*** (0.77 - 0.82)
Daily use	0.69*** (0.68 - 0.70)	0.59*** (0.58 - 0.61)	0.82*** (0.80 - 0.84)
Age (18-29= ref)			
30-44	1.11*** (1.09 - 1.12)	1.09*** (1.07 - 1.11)	1.13*** (1.11 - 1.16)
45-64	1.43*** (1.40 - 1.45)	1.39*** (1.36 - 1.42)	1.48*** (1.44 - 1.53)
Gender (Female=ref)			
Male	0.92*** (0.91 - 0.93)	0.92*** (0.90 - 0.93)	0.92*** (0.90 - 0.94)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.94*** (0.92 - 0.97)	0.88*** (0.85 - 0.91)	1.01 (0.98 - 1.05)

Hispanic	1.06*** (1.04 - 1.08)	0.97 (0.95 - 1.00)	1.14*** (1.11 - 1.18)
Other	0.91*** (0.88 - 0.94)	0.90*** (0.87 - 0.94)	0.92** (0.87 - 0.97)
Education (Less than high school= ref)			
Highschool or higher	1.02* (1.00 - 1.03)	1.05*** (1.03 - 1.07)	0.97* (0.95 - 1.00)
Number of arrests (0= ref)			
1	0.91*** (0.89 - 0.93)	0.97 (0.94 - 1.00)	0.84*** (0.81 - 0.88)
2 or more	1.15*** (1.08 - 1.21)	1.10** (1.03 - 1.18)	1.04 (0.93 - 1.17)
Employment status (Unemployed= ref)			
Employed	0.88*** (0.86 - 0.89)	0.87*** (0.85 - 0.88)	0.88*** (0.86 - 0.90)
Comorbidity (No= ref)			
Yes	0.97*** (0.96 - 0.99)	1.00 (0.98 - 1.02)	0.97** (0.95 - 0.99)
Homeless (No= ref)			
Yes	0.76*** (0.74 - 0.78)	0.77*** (0.75 - 0.80)	0.77*** (0.75 - 0.80)
Polysubstance use (no= ref)			
One more	0.92*** (0.90 - 0.93)	0.95*** (0.94 - 0.97)	0.90*** (0.88 - 0.92)
Two or more	0.88*** (0.87 - 0.89)	0.96*** (0.94 - 0.98)	0.80*** (0.78 - 0.82)
Year			
2011	1.03** (1.01 - 1.06)	1.05*** (1.02 - 1.09)	0.97 (0.93 - 1.01)
2012	1.12*** (1.09 - 1.15)	1.12*** (1.09 - 1.16)	1.09*** (1.04 - 1.14)
2013	1.13*** (1.10 - 1.16)	1.13*** (1.09 - 1.16)	1.10*** (1.05 - 1.15)
2014	1.25*** (1.20 - 1.30)	1.42*** (1.35 - 1.49)	0.95 (0.88 - 1.02)
2015	1.12*** (1.07 - 1.16)	1.42*** (1.35 - 1.49)	0.74*** (0.69 - 0.80)
2016	1.05** (1.01 - 1.10)	1.26*** (1.20 - 1.33)	0.76*** (0.71 - 0.82)

2017	1.02 (0.99 - 1.06)	1.28*** (1.22 - 1.34)	0.73*** (0.68 - 0.78)
State			
Alaska	3.86*** (2.76 - 5.40)	3.38*** (2.02 - 5.67)	3.11*** (1.90 - 5.09)
Arizona	4.96*** (3.62 - 6.80)	5.07*** (3.08 - 8.36)	3.87*** (2.57 - 5.83)
Arkansas	1.12 (0.80 - 1.57)	1.02 (0.60 - 1.72)	1.17 (0.76 - 1.82)
Colorado	2.00*** (1.46 - 2.74)	1.61 (0.98 - 2.65)	2.17*** (1.45 - 3.23)
Connecticut	1.56** (1.14 - 2.13)	0.94 (0.57 - 1.55)	1.96*** (1.31 - 2.91)
Delaware	1.57** (1.15 - 2.16)	1.72* (1.04 - 2.84)	1.03 (0.69 - 1.55)
District of Columbia	4.77*** (3.31 - 6.86)	4.35*** (2.54 - 7.46)	6.48*** (3.43 - 12.26)
Florida	1.51* (1.10 - 2.08)	1.08 (0.65 - 1.79)	1.89** (1.26 - 2.83)
Hawaii	0.58* (0.37 - 0.90)	0.31*** (0.17 - 0.59)	3.29** (1.34 - 8.10)
Idaho	3.09*** (2.20 - 4.32)	2.38*** (1.42 - 3.98)	2.64** (1.34 - 5.19)
Illinois	0.44*** (0.32 - 0.60)	0.48** (0.29 - 0.79)	0.25*** (0.17 - 0.37)
Indiana	2.25*** (1.65 - 3.09)	1.88* (1.14 - 3.10)	2.13*** (1.40 - 3.24)
Iowa	2.20*** (1.60 - 3.03)	1.97** (1.19 - 3.25)	1.82** (1.17 - 2.82)
Kansas	3.02*** (2.10 - 4.35)	2.56*** (1.50 - 4.35)	
Kentucky	0.20*** (0.15 - 0.27)	0.18*** (0.11 - 0.29)	0.22*** (0.15 - 0.32)
Louisiana	2.21*** (1.59 - 3.06)	2.18** (1.32 - 3.63)	0.63 (0.36 - 1.09)
Maine	1.78*** (1.30 - 2.44)	1.68* (1.02 - 2.78)	1.95*** (1.31 - 2.89)
Maryland	1.82*** (1.33 - 2.48)	1.56 (0.95 - 2.56)	1.83** (1.23 - 2.72)
Massachusetts	1.75*** (1.28 - 2.40)	1.71* (1.04 - 2.81)	1.68* (1.13 - 2.50)
Michigan	1.48* (0.99 - 1.06)	1.12 (0.60 - 1.72)	1.93** (0.76 - 1.82)

	(1.09 - 2.03)	(0.68 - 1.84)	(1.30 - 2.87)
Mississippi	1.14	0.89	1.31
	(0.81 - 1.61)	(0.53 - 1.50)	(0.51 - 3.39)
Missouri	1.65**	1.14	2.76***
	(1.21 - 2.26)	(0.69 - 1.87)	(1.85 - 4.12)
Montana	2.22***	1.81*	
	(1.61 - 3.08)	(1.09 - 3.00)	
Nebraska	1.14	0.98	1.03
	(0.79 - 1.66)	(0.57 - 1.69)	(0.52 - 2.02)
Nevada	1.87*	0.86	3.10**
	(1.03 - 3.39)	(0.33 - 2.28)	(1.40 - 6.89)
New Hampshire	1.32	1.07	1.86*
	(0.95 - 1.82)	(0.64 - 1.77)	(1.16 - 2.99)
New Jersey	1.79***	1.39	1.82**
	(1.31 - 2.45)	(0.84 - 2.28)	(1.22 - 2.70)
New Mexico	1.1	0.43	1.2
	(0.65 - 1.85)	(0.13 - 1.48)	(0.66 - 2.20)
New York	1.86***	1.6	2.02***
	(1.37 - 2.54)	(0.98 - 2.64)	(1.36 - 3.01)
North Carolina	0.38***	0.37***	0.29***
	(0.28 - 0.51)	(0.22 - 0.60)	(0.20 - 0.43)
North Dakota	2.52***	2.09*	
	(1.64 - 3.87)	(1.17 - 3.73)	
Ohio	1.99***	1.82*	1.92**
	(1.46 - 2.72)	(1.11 - 2.99)	(1.29 - 2.86)
Oklahoma	3.79***	3.14***	
	(2.68 - 5.36)	(1.87 - 5.27)	
Pennsylvania	1.29	1.08	1.42
	(0.94 - 1.78)	(0.65 - 1.79)	(0.93 - 2.15)
Rhode Island	2.28***	1.19	2.66***
	(1.66 - 3.12)	(0.72 - 1.98)	(1.78 - 3.96)
South Carolina	1.95***	1.86*	1.33
	(1.42 - 2.68)	(1.13 - 3.08)	(0.85 - 2.07)
South Dakota	2.26***	1.76*	2.23*
	(1.58 - 3.24)	(1.03 - 2.99)	(1.05 - 4.73)
Tennessee	1.89***	1.52	18.45**
	(1.36 - 2.63)	(0.91 - 2.53)	(2.28 - 149.58)
Utah	2.73***	2.89***	1.62*
	(2.00 - 3.74)	(1.75 - 4.76)	(1.08 - 2.42)
Washington	2.47***	1.93**	2.92***
	(1.81 - 3.38)	(1.17 - 3.17)	(1.96 - 4.35)
Wyoming	3.64***	2.82***	2.22

(2.37 - 5.59)

(1.57 - 5.05)

(0.67 - 7.30)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B16. DID model for the adjusted associations between Medicaid expansion and treatment length of stay

	DID pooled model	DID model Non-MAT	DID model MAT
N	503,363	313,253	190,110
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat	2.41***	1.86*	2.88***
Expansion states	(1.76 - 3.29)	(1.13 - 3.07)	(1.94 - 4.29)
Expansion	0.98	1.20***	0.72***
After the ACA implementation (2014)	(0.94 - 1.02)	(1.14 - 1.26)	(0.67 - 0.77)
Medicaid expansion	0.99	0.92***	1.13***
Medicaid expansion	(0.95 - 1.03)	(0.88 - 0.97)	(1.06 - 1.21)
MAT (No= ref)	2.08***		
Yes	(2.05 - 2.11)		
Referral sources			
Healthcare provider referral	0.83***	0.95***	0.80***
	(0.81 - 0.84)	(0.93 - 0.97)	(0.78 - 0.82)
Institutional referral	1.00	1.15***	0.88***
	(0.97 - 1.02)	(1.12 - 1.18)	(0.85 - 0.92)
Court/criminal justice	1.35***	1.61***	0.72***
	(1.33 - 1.37)	(1.58 - 1.65)	(0.69 - 0.75)
Frequency of use (No past month use= ref)			
Some use	0.68***	0.64***	0.80***
	(0.67 - 0.69)	(0.63 - 0.65)	(0.77 - 0.82)
Daily use	0.69***	0.59***	0.82***
	(0.68 - 0.70)	(0.58 - 0.61)	(0.80 - 0.85)
Age (18-29= ref)			
30-44	1.11***	1.10***	1.14***
	(1.09 - 1.13)	(1.08 - 1.12)	(1.11 - 1.17)
45-64	1.43***	1.39***	1.49***
	(1.40 - 1.45)	(1.36 - 1.42)	(1.44 - 1.53)
Gender (Female=ref)			
Male	0.93***	0.92***	0.93***
	(0.92 - 0.94)	(0.91 - 0.94)	(0.91 - 0.94)
Race/ethnicity (non- Hispanic White=ref)			
Non-Hispanic Black	0.95***	0.89***	1.01

	(0.93 - 0.97)	(0.86 - 0.92)	(0.98 - 1.05)
Hispanic	1.06***	0.97	1.14***
	(1.04 - 1.08)	(0.95 - 1.00)	(1.11 - 1.18)
Other	0.91***	0.91***	0.92**
	(0.88 - 0.95)	(0.87 - 0.95)	(0.87 - 0.97)
Education (Less than high school= ref)			
Highschool or higher	1.01*	1.05***	0.97*
	(1.00 - 1.03)	(1.03 - 1.07)	(0.95 - 1.00)
Number of arrests (0= ref)			
1	0.92***	0.99	0.84***
	(0.89 - 0.94)	(0.95 - 1.02)	(0.81 - 0.88)
2 or more	1.17***	1.13**	1.05
	(1.10 - 1.24)	(1.05 - 1.21)	(0.94 - 1.17)
Employment status (Unemployed= ref)			
Employed	0.89***	0.88***	0.88***
	(0.87 - 0.90)	(0.86 - 0.89)	(0.86 - 0.90)
Comorbidity (No= ref)			
Yes	0.98**	1.01	0.97*
	(0.97 - 0.99)	(0.99 - 1.02)	(0.95 - 0.99)
Homeless (No= ref)			
Yes	0.76***	0.77***	0.77***
	(0.74 - 0.78)	(0.75 - 0.80)	(0.74 - 0.80)
Polysubstance use (no= ref)			
One more	0.91***	0.95***	0.90***
	(0.90 - 0.93)	(0.93 - 0.97)	(0.88 - 0.92)
Two or more	0.88***	0.96***	0.79***
	(0.86 - 0.89)	(0.94 - 0.98)	(0.77 - 0.82)
Year			
2011	1.04**	1.06***	0.97
	(1.01 - 1.06)	(1.03 - 1.09)	(0.93 - 1.02)
2012	1.13***	1.12***	1.09***
	(1.10 - 1.16)	(1.09 - 1.16)	(1.05 - 1.14)
2013	1.12***	1.11***	1.10***
	(1.09 - 1.14)	(1.07 - 1.14)	(1.05 - 1.15)
2014	1.24***	1.14***	1.29***
	(1.21 - 1.27)	(1.10 - 1.17)	(1.24 - 1.34)
2015	1.11***	1.15***	1.01
	(1.08 - 1.14)	(1.11 - 1.18)	(0.98 - 1.05)
2016	1.07***	1.06***	1.04**
	(1.05 - 1.10)	(1.03 - 1.10)	(1.01 - 1.08)
2017	-	-	-
State			

Arizona	2.02*** (1.90 - 2.14)	2.65*** (2.45 - 2.85)	1.33*** (1.18 - 1.50)
Arkansas	0.46*** (0.40 - 0.52)	0.53*** (0.45 - 0.63)	0.40*** (0.33 - 0.49)
Colorado	0.81*** (0.77 - 0.86)	0.84*** (0.78 - 0.90)	0.74*** (0.69 - 0.81)
Connecticut	0.63*** (0.60 - 0.66)	0.48*** (0.45 - 0.52)	0.67*** (0.63 - 0.71)
Delaware	0.64*** (0.59 - 0.68)	0.89** (0.81 - 0.97)	0.35*** (0.32 - 0.40)
District of Columbia	1.93*** (1.59 - 2.34)	2.25*** (1.82 - 2.79)	2.22** (1.34 - 3.68)
Florida	1.48* (1.08 - 2.03)	1.05 (0.63 - 1.74)	1.87** (1.25 - 2.81)
Hawaii	0.23*** (0.17 - 0.32)	0.16*** (0.11 - 0.24)	1.13 (0.50 - 2.54)
Idaho	3.07*** (2.19 - 4.30)	2.35** (1.41 - 3.93)	2.62** (1.33 - 5.15)
Illinois	0.18*** (0.17 - 0.19)	0.25*** (0.24 - 0.27)	0.09*** (0.08 - 0.09)
Iowa	0.89** (0.83 - 0.96)	1.02 (0.94 - 1.11)	0.62*** (0.51 - 0.76)
Kansas	3.00*** (2.09 - 4.33)	2.52*** (1.48 - 4.29)	
Kentucky	0.08*** (0.08 - 0.09)	0.09*** (0.09 - 0.10)	0.07*** (0.07 - 0.08)
Maine	1.76*** (1.29 - 2.41)	1.66* (1.00 - 2.73)	1.95*** (1.31 - 2.89)
Maryland	0.74*** (0.71 - 0.77)	0.81*** (0.76 - 0.86)	0.63*** (0.59 - 0.67)
Massachusetts	0.71*** (0.68 - 0.74)	0.89*** (0.84 - 0.94)	0.57*** (0.54 - 0.61)
Michigan	0.60*** (0.58 - 0.63)	0.58*** (0.55 - 0.62)	0.66*** (0.62 - 0.70)
Mississippi	1.14 (0.81 - 1.61)	0.89 (0.53 - 1.49)	1.32 (0.51 - 3.42)
Missouri	1.64** (1.20 - 2.25)	1.12 (0.68 - 1.84)	2.76*** (1.85 - 4.12)
Nebraska	1.14 (0.78 - 1.65)	0.97 (0.56 - 1.67)	1.02 (0.52 - 2.01)
Nevada	0.75 (0.45 - 1.25)	0.45 (0.19 - 1.03)	1.06 (0.53 - 2.13)
New Hampshire	0.53*** (0.48 - 0.59)	0.55*** (0.49 - 0.62)	0.64*** (0.49 - 0.83)
New Jersey	0.73*** (0.69 - 0.76)	0.72*** (0.67 - 0.77)	0.62*** (0.58 - 0.66)

New Mexico	0.44*** (0.29 - 0.67)	0.23** (0.07 - 0.69)	0.41*** (0.26 - 0.65)
New York	0.76*** (0.73 - 0.78)	0.84*** (0.79 - 0.88)	0.69*** (0.66 - 0.73)
North Carolina	0.38*** (0.28 - 0.51)	0.37*** (0.22 - 0.60)	0.29*** (0.20 - 0.43)
North Dakota	1.03 (0.76 - 1.38)	1.09 (0.80 - 1.47)	
Ohio	0.81*** (0.77 - 0.84)	0.94* (0.89 - 1.00)	0.66*** (0.61 - 0.71)
Oklahoma	3.74*** (2.65 - 5.28)	3.06*** (1.82 - 5.15)	
Rhode Island	0.92** (0.87 - 0.97)	0.62*** (0.56 - 0.69)	0.91* (0.85 - 0.98)
South Carolina	1.93*** (1.41 - 2.66)	1.84* (1.11 - 3.03)	1.33 (0.85 - 2.08)
South Dakota	2.26*** (1.58 - 3.23)	1.74* (1.02 - 2.95)	2.23* (1.05 - 4.74)
Tennessee	1.87*** (1.35 - 2.61)	1.49 (0.90 - 2.48)	18.53** (2.29 - 150.29)
Utah	2.71*** (1.98 - 3.71)	2.84*** (1.72 - 4.67)	1.61* (1.08 - 2.41)
Washington	-	-	-
Wyoming	3.68*** (2.40 - 5.65)	2.83*** (1.58 - 5.07)	2.23 (0.68 - 7.35)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B17. 2WFE model for the adjusted associations between Medicaid expansion and treatment completion

	2 ways fixed effect pooled model	Non-MAT	MAT
N	518,146	326,025	192,121
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Medicaid expansion	0.87***	1.10***	0.52***
Expansion	(0.84 - 0.90)	(1.06 - 1.15)	(0.48 - 0.55)
MAT (No= ref)			
Yes	0.78*** (0.77 - 0.79)		
Referral sources (Self-referral= ref)			
Healthcare provider referral	1.38*** (1.35 - 1.40)	1.32*** (1.29 - 1.35)	1.42*** (1.39 - 1.46)
Institutional referral	1.30*** (1.27 - 1.33)	1.32*** (1.28 - 1.35)	1.21*** (1.16 - 1.26)
Court/criminal justice	2.01*** (1.97 - 2.04)	1.99*** (1.95 - 2.03)	1.73*** (1.66 - 1.80)
Frequency of use (No past month use= ref)			
Some use	0.66*** (0.65 - 0.68)	0.69*** (0.67 - 0.70)	0.62*** (0.60 - 0.65)
Daily use	0.69*** (0.68 - 0.70)	0.86*** (0.84 - 0.87)	0.51*** (0.50 - 0.52)
Age (18-29= ref)			
30-44	1.05*** (1.04 - 1.07)	1.08*** (1.06 - 1.10)	1.00 (0.97 - 1.03)
45-64	1.17*** (1.15 - 1.20)	1.27*** (1.24 - 1.30)	1.01 (0.98 - 1.04)
Gender (Female=ref)			
Male	0.90*** (0.89 - 0.91)	0.93*** (0.92 - 0.95)	0.84*** (0.83 - 0.86)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96**	1.13***	0.77***

	(0.94 - 0.99)	(1.10 - 1.17)	(0.74 - 0.80)
Hispanic	0.86***	0.91***	0.79***
	(0.84 - 0.88)	(0.89 - 0.94)	(0.76 - 0.82)
Other	0.79***	0.84***	0.69***
	(0.76 - 0.82)	(0.81 - 0.88)	(0.65 - 0.74)
Education (Less than high school= ref)			
Highschool or higher	1.19***	1.17***	1.20***
	(1.16 - 1.21)	(1.14 - 1.20)	(1.15 - 1.25)
Number of arrests (0= ref)			
1	1.15***	1.19***	1.04
	(1.10 - 1.20)	(1.13 - 1.24)	(0.94 - 1.14)
2 or more	0.84***	0.89*	1.03
	(0.78 - 0.91)	(0.81 - 0.97)	(0.83 - 1.29)
Employment status (Unemployed= ref)			
Employed	1.11***	1.12***	1.10***
	(1.10 - 1.13)	(1.10 - 1.14)	(1.07 - 1.12)
Comorbidity (No= ref)			
Yes	0.88***	0.87***	0.92***
	(0.87 - 0.89)	(0.86 - 0.89)	(0.90 - 0.94)
Homeless (No= ref)			
Yes	0.98	0.98	0.98
	(0.96 - 1.01)	(0.95 - 1.01)	(0.94 - 1.02)
Polysubstance use (no= ref)			
One more	0.97***	1.00	0.91***
	(0.95 - 0.98)	(0.98 - 1.01)	(0.89 - 0.94)
Two or more	0.99	1.02*	0.93***
	(0.97 - 1.00)	(1.00 - 1.04)	(0.90 - 0.95)
Year			
2011	0.99	1.03*	0.87***
	(0.96 - 1.01)	(1.00 - 1.06)	(0.83 - 0.91)
2012	0.99	1.03*	0.92***
	(0.97 - 1.02)	(1.00 - 1.06)	(0.87 - 0.96)
2013	0.95***	1.01	0.85***
	(0.93 - 0.98)	(0.98 - 1.04)	(0.81 - 0.89)
2014	1.09***	0.93**	1.58***
	(1.05 - 1.13)	(0.89 - 0.97)	(1.46 - 1.71)
2015	1.11***	1.00	1.47***
	(1.06 - 1.15)	(0.95 - 1.05)	(1.36 - 1.59)
2016	1.16***	1.02	1.61***
	(1.12 - 1.21)	(0.98 - 1.07)	(1.49 - 1.75)

2017	1.38*** (1.33 - 1.43)	1.23*** (1.18 - 1.29)	1.78*** (1.65 - 1.93)
State			
Alaska	2.47*** (1.70 - 3.59)	2.50*** (1.46 - 4.30)	1.83* (1.02 - 3.28)
Arizona	1.07 (0.75 - 1.53)	0.81 (0.48 - 1.37)	2.16** (1.32 - 3.53)
Arkansas	2.78*** (1.91 - 4.04)	2.65*** (1.53 - 4.57)	3.35*** (2.00 - 5.61)
Colorado	4.54*** (3.18 - 6.48)	3.80*** (2.24 - 6.43)	6.65*** (4.11 - 10.76)
Connecticut	6.22*** (4.37 - 8.87)	3.67*** (2.16 - 6.21)	10.18*** (6.30 - 16.45)
Delaware	2.87*** (2.01 - 4.11)	2.20** (1.29 - 3.73)	5.10*** (3.13 - 8.31)
District of Columbia	3.88*** (2.62 - 5.74)	2.47** (1.41 - 4.32)	9.44*** (5.20 - 17.16)
Florida	14.81*** (10.32 - 21.26)	6.29*** (3.70 - 10.72)	66.07*** (39.74 - 109.87)
Hawaii	6.36*** (4.02 - 10.04)	6.42*** (3.46 - 11.90)	5.08*** (2.12 - 12.18)
Idaho	3.51*** (2.41 - 5.11)	3.76*** (2.19 - 6.46)	3.99*** (1.95 - 8.16)
Illinois	9.53*** (6.69 - 13.59)	7.04*** (4.16 - 11.90)	18.85*** (11.63 - 30.55)
Indiana	0.73 (0.51 - 1.04)	0.68 (0.40 - 1.15)	0.79 (0.47 - 1.32)
Iowa	1.83*** (1.28 - 2.62)	1.87* (1.10 - 3.17)	0.66 (0.37 - 1.17)
Kansas	3.57*** (2.39 - 5.32)	3.51*** (2.01 - 6.12)	
Kentucky	12.69*** (8.90 - 18.08)	11.53*** (6.82 - 19.50)	16.75*** (10.34 - 27.12)
Louisiana	2.54*** (1.76 - 3.66)	2.22** (1.30 - 3.78)	7.89*** (4.27 - 14.57)
Maine	1.41 (0.99 - 2.01)	1.51 (0.89 - 2.57)	1.23 (0.76 - 1.98)
Maryland	2.78*** (1.95 - 3.95)	2.39** (1.41 - 4.04)	3.80*** (2.35 - 6.14)
Massachusetts	1.98*** (1.39 - 2.82)	1.68 (0.99 - 2.84)	2.59*** (1.60 - 4.18)
Michigan	2.18***	1.83*	3.10***

	(1.53 - 3.10)	(1.08 - 3.09)	(1.92 - 5.00)
Mississippi	2.25***	2.42**	0.69
	(1.54 - 3.29)	(1.41 - 4.16)	(0.21 - 2.29)
Missouri	3.22***	3.91***	2.48***
	(2.26 - 4.60)	(2.31 - 6.62)	(1.53 - 4.02)
Montana	3.96***	3.95***	
	(2.74 - 5.72)	(2.32 - 6.74)	
Nebraska	6.99***	7.36***	5.81***
	(4.61 - 10.60)	(4.14 - 13.10)	(2.76 - 12.21)
Nevada	1.69	2.34	1.54
	(0.88 - 3.24)	(0.90 - 6.06)	(0.59 - 4.03)
New Hampshire	10.21***	9.52***	10.42***
	(7.05 - 14.78)	(5.56 - 16.31)	(5.99 - 18.13)
New Jersey	2.15***	3.43***	2.01**
	(1.51 - 3.06)	(2.03 - 5.81)	(1.25 - 3.25)
New Mexico	16.75***	7.04**	26.62***
	(9.20 - 30.51)	(2.18 - 22.71)	(12.87 - 55.07)
New York	1.47*	1.37	1.95**
	(1.03 - 2.09)	(0.81 - 2.32)	(1.21 - 3.15)
North Carolina	11.60***	9.44***	31.32***
	(8.15 - 16.51)	(5.59 - 15.94)	(19.35 - 50.68)
North Dakota	3.23***	3.12***	
	(2.04 - 5.11)	(1.71 - 5.69)	
Ohio	1.31	1.38	1.11
	(0.92 - 1.87)	(0.81 - 2.33)	(0.69 - 1.80)
Oklahoma	2.39***	2.46**	
	(1.64 - 3.50)	(1.43 - 4.23)	
Pennsylvania	2.51***	2.81***	2.09**
	(1.75 - 3.60)	(1.65 - 4.79)	(1.27 - 3.45)
Rhode Island	3.00***	1.88*	4.29***
	(2.10 - 4.28)	(1.11 - 3.21)	(2.65 - 6.93)
South Carolina	2.27***	2.34**	1.6
	(1.58 - 3.25)	(1.38 - 3.97)	(0.95 - 2.71)
South Dakota	3.26***	3.52***	3.92**
	(2.19 - 4.84)	(2.02 - 6.15)	(1.72 - 8.95)
Tennessee	1.3	1.32	8.80**
	(0.90 - 1.89)	(0.77 - 2.26)	(2.15 - 36.00)
Utah	4.19***	5.03***	2.63***
	(2.94 - 5.98)	(2.97 - 8.52)	(1.62 - 4.26)
Washington	2.80***	2.95***	3.31***
	(1.96 - 3.99)	(1.74 - 5.00)	(2.05 - 5.36)
Wyoming	4.54***	5.00***	4.66*

(2.86 - 7.20)

(2.72 - 9.17)

(1.29 - 16.85)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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

Table 4-B18. DID model for the adjusted association between Medicaid expansion and treatment completion

	DID pooled model	DID model Non-MAT	DID model MAT
N	503,355	313,251	190,104
	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Treat			
Expansion states	2.79*** (1.96 - 3.98)	2.95*** (1.74 - 4.99)	3.28*** (2.03 - 5.30)
Expansion			
After the ACA implementation (2014)	1.40*** (1.34 - 1.45)	1.26*** (1.20 - 1.31)	1.76*** (1.63 - 1.90)
Medicaid expansion			
Expansion	0.89*** (0.86 - 0.92)	1.14*** (1.09 - 1.19)	0.53*** (0.49 - 0.57)
MAT (No= ref)			
Yes	0.78*** (0.77 - 0.79)		
Referral sources			
Healthcare provider referral	1.38*** (1.36 - 1.41)	1.32*** (1.30 - 1.35)	1.43*** (1.39 - 1.47)
Institutional referral	1.29*** (1.26 - 1.32)	1.30*** (1.27 - 1.34)	1.21*** (1.16 - 1.26)
Court/criminal justice	2.01*** (1.97 - 2.04)	1.99*** (1.95 - 2.03)	1.73*** (1.66 - 1.81)
Frequency of use (No past month use= ref)			
Some use	0.67*** (0.66 - 0.68)	0.70*** (0.68 - 0.71)	0.62*** (0.60 - 0.64)
Daily use	0.70*** (0.69 - 0.71)	0.88*** (0.86 - 0.89)	0.51*** (0.50 - 0.52)
Age (18-29= ref)			
30-44	1.06*** (1.04 - 1.07)	1.08*** (1.06 - 1.10)	1.00 (0.98 - 1.03)
45-64	1.18*** (1.15 - 1.20)	1.28*** (1.25 - 1.31)	1.01 (0.98 - 1.05)
Gender (Female=ref)			
Male	0.89*** (0.88 - 0.91)	0.93*** (0.91 - 0.94)	0.84*** (0.82 - 0.86)
Race/ethnicity (non-Hispanic White=ref)			
Non-Hispanic Black	0.96**	1.13***	0.77***

	(0.94 - 0.99)	(1.10 - 1.17)	(0.74 - 0.80)
Hispanic	0.86***	0.91***	0.79***
	(0.84 - 0.88)	(0.88 - 0.93)	(0.76 - 0.82)
Other	0.79***	0.85***	0.69***
	(0.76 - 0.82)	(0.81 - 0.89)	(0.65 - 0.74)
Education (Less than high school= ref)			
Highschool or higher	1.11***	1.12***	1.10***
	(1.09 - 1.13)	(1.10 - 1.14)	(1.07 - 1.12)
Number of arrests (0= ref)			
1	1.03	1.07***	0.93**
	(1.00 - 1.06)	(1.04 - 1.11)	(0.89 - 0.98)
2 or more	0.76***	0.79***	0.85*
	(0.72 - 0.81)	(0.74 - 0.85)	(0.74 - 0.96)
Employment status (Unemployed= ref)			
Employed	1.02*	1.05***	0.99
	(1.00 - 1.03)	(1.03 - 1.07)	(0.97 - 1.02)
Comorbidity (No= ref)			
Yes	0.88***	0.87***	0.92***
	(0.87 - 0.89)	(0.86 - 0.89)	(0.90 - 0.94)
Homeless (No= ref)			
Yes	0.98	0.99	0.98
	(0.96 - 1.01)	(0.96 - 1.02)	(0.94 - 1.02)
Polysubstance use (no= ref)			
One more	0.97***	0.99	0.91***
	(0.95 - 0.98)	(0.97 - 1.01)	(0.89 - 0.94)
Two or more	0.98*	1.01	0.92***
	(0.96 - 1.00)	(0.99 - 1.03)	(0.90 - 0.95)
Year			
2011	0.98	1.03	0.87***
	(0.96 - 1.01)	(1.00 - 1.06)	(0.83 - 0.91)
2012	0.98	1.02	0.91***
	(0.96 - 1.01)	(0.99 - 1.05)	(0.87 - 0.96)
2013	0.95***	1.00	0.84***
	(0.92 - 0.97)	(0.97 - 1.03)	(0.80 - 0.88)
2014	0.77***	0.72***	0.88***
	(0.75 - 0.78)	(0.70 - 0.74)	(0.84 - 0.91)
2015	0.78***	0.78***	0.81***
	(0.76 - 0.80)	(0.75 - 0.80)	(0.78 - 0.85)
2016	0.82***	0.80***	0.90***
	(0.81 - 0.84)	(0.78 - 0.83)	(0.87 - 0.93)
2017	-	-	-
State			
Arizona	0.38***	0.27***	0.65***
	(0.35 - 0.40)	(0.25 - 0.29)	(0.58 - 0.73)

Arkansas	0.99 (0.87 - 1.12)	0.89 (0.75 - 1.04)	1.01 (0.82 - 1.23)
Colorado	1.61*** (1.53 - 1.70)	1.27*** (1.18 - 1.37)	2.00*** (1.85 - 2.16)
Connecticut	2.19*** (2.09 - 2.29)	1.22*** (1.13 - 1.31)	3.06*** (2.86 - 3.26)
Delaware	1.02 (0.95 - 1.10)	0.74*** (0.67 - 0.81)	1.53*** (1.37 - 1.72)
District of Columbia	1.37*** (1.15 - 1.63)	0.82 (0.67 - 1.00)	2.84*** (1.98 - 4.08)
Florida	14.81*** (10.31 - 21.25)	6.32*** (3.71 - 10.76)	65.49*** (39.38 - 108.89)
Hawaii	2.26*** (1.69 - 3.03)	2.16*** (1.55 - 3.00)	1.53 (0.74 - 3.19)
Idaho	3.54*** (2.43 - 5.15)	3.81*** (2.22 - 6.55)	3.96*** (1.94 - 8.11)
Illinois	3.36*** (3.20 - 3.52)	2.33*** (2.19 - 2.47)	5.66*** (5.19 - 6.18)
Iowa	0.65*** (0.60 - 0.70)	0.63*** (0.57 - 0.68)	0.20*** (0.14 - 0.27)
Kansas	3.55*** (2.38 - 5.30)	3.48*** (2.00 - 6.08)	
Kentucky	4.50*** (4.29 - 4.71)	3.87*** (3.64 - 4.11)	5.03*** (4.63 - 5.45)
Maine	1.42 (0.99 - 2.02)	1.53 (0.90 - 2.59)	1.23 (0.76 - 1.98)
Maryland	0.99 (0.95 - 1.04)	0.81*** (0.76 - 0.86)	1.15*** (1.08 - 1.22)
Massachusetts	0.70*** (0.67 - 0.73)	0.56*** (0.52 - 0.59)	0.78*** (0.73 - 0.84)
Michigan	0.77*** (0.74 - 0.80)	0.61*** (0.57 - 0.64)	0.93* (0.87 - 0.99)
Mississippi	2.24*** (1.53 - 3.28)	2.40** (1.40 - 4.13)	0.69 (0.21 - 2.29)
Missouri	3.25*** (2.28 - 4.63)	3.97*** (2.35 - 6.72)	2.49*** (1.54 - 4.03)
Nebraska	7.01*** (4.62 - 10.64)	7.42*** (4.17 - 13.20)	5.78*** (2.75 - 12.16)
Nevada	0.6 (0.35 - 1.03)	0.77 (0.35 - 1.70)	0.46 (0.20 - 1.07)
New Hampshire	3.61*** (3.21 - 4.06)	3.17*** (2.78 - 3.62)	3.14*** (2.36 - 4.17)
New Jersey	0.76*** (0.73 - 0.80)	1.16*** (1.08 - 1.23)	0.61*** (0.57 - 0.65)
New Mexico	5.97*** (3.67 - 9.71)	2.36 (0.83 - 6.73)	8.02*** (4.62 - 13.90)

New York	0.52*** (0.51 - 0.54)	0.46*** (0.44 - 0.49)	0.59*** (0.55 - 0.62)
North Carolina	11.53*** (8.10 - 16.41)	9.35*** (5.54 - 15.80)	31.25*** (19.31 - 50.56)
North Dakota	1.15 (0.86 - 1.55)	1.06 (0.78 - 1.42)	
Ohio	0.47*** (0.45 - 0.49)	0.46*** (0.44 - 0.49)	0.34*** (0.31 - 0.36)
Oklahoma	2.42*** (1.65 - 3.53)	2.49*** (1.45 - 4.29)	
Rhode Island	1.06* (1.01 - 1.12)	0.63*** (0.57 - 0.70)	1.29*** (1.20 - 1.39)
South Carolina	2.27*** (1.59 - 3.26)	2.36** (1.39 - 4.00)	1.6 (0.95 - 2.71)
South Dakota	3.28*** (2.21 - 4.89)	3.58*** (2.05 - 6.25)	3.90** (1.71 - 8.91)
Tennessee	1.31 (0.90 - 1.90)	1.33 (0.78 - 2.28)	8.82** (2.16 - 36.06)
Utah	4.21*** (2.95 - 6.00)	5.07*** (3.00 - 8.59)	2.63*** (1.62 - 4.27)
Washington	-	-	-
Wyoming	4.54*** (2.86 - 7.21)	5.03*** (2.74 - 9.24)	4.65* (1.29 - 16.79)

Adjusted Odds Ratio = AOR. Confidence Interval = CI.

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