

Investigating heterogeneous effects of an expanded methadone access policy with opioid treatment program retention: a Rhode Island population-based retrospective cohort study

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Abstract

Following federal regulatory changes during the COVID-19 pandemic, Rhode Island expanded methadone access for opioid treatment programs (OTPs) in March 2020. The policy, which permitted take-home dosing for patients, contrasted with longstanding restrictions on methadone. This study used patient-level OTP admission and discharge records to compare six-month retention before and after the policy change. We conducted a retrospective cohort study of 1248 patients newly admitted to OTPs between March 18 and June 30 of 2019 (pre-policy) and 2020 (post-policy). We used logistic regression to estimate associations with retention before and after the policy and used a machine learning approach, the heterogeneous treatment effect (HTE)-Scan, to explore heterogeneity in retention across subgroups. Overall, we found no change in retention following the policy, with an adjusted OR of 1.08 (95% CI, 0.80, 1.45) and adjusted RR of 1.03 (0.90–1.18). Using HTE-Scan, we identified two subgroups with significantly increased retention above the overall cohort: (1) patients with below high-school education and past-month arrest and (2) male, non-Hispanic white or Hispanic/Latino patients reporting heroin or fentanyl use with past-month arrest. We identified no subgroups with significantly decreased retention. Collectively, findings suggest that expanded methadone access may benefit vulnerable populations without harming overall retention.

Key words: treatment retention; methadone; COVID-19; heterogeneous treatment effects; machine learning; Rhode Island; HTE-scan.

Introduction

Methadone, an opioid agonist medication treatment for opioid use disorder (OUD), has been widely used in the United States since the 1960s.¹ Despite its demonstrated effectiveness and association with significantly reduced risk of overdose mortality,^{2,3} methadone for the treatment of OUD remains tightly regulated in the United States.⁴ Federal restrictions on medication distribution, prescription, and dosing require most patients to receive daily treatment in person through specialized opioid treatment programs (OTPs).⁴

In response to temporary service reductions or closures of substance use disorder (SUD) and harm reduction services during the first wave of the COVID-19 pandemic,⁵ federal policymakers made efforts to ensure that patients engaged in methadone therapy could continue treatment in the presence of pandemic travel and service access restrictions. In March 2020, the US Substance Abuse and Mental Health Services Administration (SAMHSA) issued an

emergency guidance authorizing states to expand the duration of methadone take-home doses from OTPs to a maximum of 28 days for “stable patients” and 14 days for “less stable patients,”^{6,7} with patient stability assessed by adherence to a given program, duration of treatment, and drug use patterns.⁸ These emergency regulations were made permanent in February 2024.^{9,10}

Following SAMHSA’s emergency ruling, OTPs implemented a range of novel models for methadone distribution,⁸ including expanded take-home doses,¹¹ increased use of telemedicine for delivery of treatment and behavioral health services,^{12–14} and medication delivery to patients in isolation.¹⁵ Prior studies have identified that the relaxation of take-home policies in several jurisdictions was associated with increased utilization of take-home dosing¹⁶ without discernable increases in adverse events, such as non-prescribed substance use.¹⁷ Further research has suggested that the expanded methadone take-home policy may have mitigated the impact of the COVID-19 pandemic

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on methadone-involved overdose deaths, as they remained stable nationally while other opioid-involved overdose deaths increased.^{18,19} Moreover, this policy change may have served to promote health equity, as methadone-involved overdose deaths decreased among non-Hispanic Black and Hispanic men in the period after the take-home policy but did not change among non-Hispanic Black and Hispanic women or white women or men.²⁰ Qualitative studies have documented increased patient satisfaction with relaxed access regulations,²¹ reduced stigma toward clinic attendance,²² and facilitation of retention in care.²³

Among possible downstream outcomes of changes to methadone policy, patient retention in care remains a primary concern, as OTP discontinuation is an established risk factor for overdose.³ In the United States, some studies indicate that the pandemic-era expanded take-home policy was not associated with poorer retention or adverse events, despite increased past-month opioid use,^{24,25} suggesting that relaxed regulations may not yield worse patient outcomes. Another study conducted in Canada identified decreased treatment interruption and discontinuation associated with similar expanded take-home policies enacted in the province of Ontario at the start of the COVID-19 pandemic.²⁶ These studies provide foundational evidence for the potential sustainability of expanded methadone access in North America. However, despite evidence to suggest that retention may not have worsened and may even have improved, population-level average effects may obscure important subgroup heterogeneity in the effect of this policy change. Assessing heterogeneity of treatment effects in epidemiologic research is crucial to inform policy implementation, including tailoring and targeting at the community or program levels to meet the needs of diverse patient populations.²⁷ In the context of methadone treatment, assessment of heterogeneous treatment effects is crucial to identify the persistence of underlying racial/ethnic and other social and demographic disparities in access to and engagement with care.^{28,29}

In Rhode Island, access to methadone was expanded through a collaborative regulatory effort across the state's public and behavioral health systems. State authorities enacted Rhode Island's expanded methadone take-home provisions for OTP patients on March 18, 2020.³⁰ To inform US opioid treatment policy, we conducted a retrospective cohort study of patients engaged in OTPs to estimate the impact of Rhode Island's expanded methadone access regulation on retention in care. Using patient-level admissions and discharge data from all patients enrolled in OTPs in Rhode Island, we estimate changes in the odds of six-month retention, comparing patients newly admitted between March 18 and June 30, 2019 to patients newly admitted between March 18 and June 30, 2020. Finally, to identify heterogeneous associations of the policy change with patient retention in care across diverse patient subgroups, we apply a novel machine learning technique, the Heterogeneous Treatment Effect (HTE)-Scan.

Methods

Data sources and study setting

Data came from the Rhode Island Department of Behavioral Healthcare, Developmental Disabilities, and Hospitals (BHDDH), which oversees SUD treatment and regulates OTPs in the state. BHDDH administrative data captures admissions to and discharges from licensed inpatient, outpatient, and detoxification programs, as well as OTPs in Rhode Island. Rhode Island has 17 OTPs servicing both the state's urban cores and suburban and rural outlying areas,³¹ and methadone access is robust across the

state.³² As such, we consider Rhode Island an ideal jurisdiction to measure the impact of methadone access policy on treatment outcomes. Data do not include office-based buprenorphine treatment, which is not the focus of this study. We limited the data to admissions to and discharges from OTPs in Rhode Island, which dispense methadone to treat OUD. Patient OTP admissions and discharges were captured as part of routine patient care and administrative data collection. Use of BHDDH data and all study procedures were approved by the Brown University School of Public Health Institutional Review Board.

Study period and sample

Data captured admissions to and discharges from OTPs in Rhode Island between January 1, 2016 and December 31, 2020. Admissions and discharges were identified using exact dates. To determine sample eligibility, we identified patient admissions to programs or services of all types, including new intakes and transfers from non-OTP programs, from January 1, 2016 through December 31, 2020, using data obtained from BHDDH. We excluded admissions related to non-OTP treatment modalities. Next, we restricted the sample to OTP patients newly admitted between March 18 and June 30, 2019 and March 18 and June 30, 2020 to exclude those with prior histories of OTP enrollment during our lookback period. Using a two-year lookback period restriction isolated changes in retention for newly admitted patients without longer histories of methadone treatment to reduce the potential for selection bias due to left censoring. These narrow enrollment windows allowed us to capture six-month retention in both our treated (2020) and control (2019) group periods while ensuring that the control group's six-month retention did not overlap with the start of the pandemic.

Exposure, outcome, and covariates

We assessed one primary exposure: the March 18, 2020 implementation of Rhode Island's expanded methadone take-home policy. Our exposed period was March 18 to June 30, 2020. Our unexposed period was March 18 to June 30, 2019. Notably, our policy exposure coincides with the start of the COVID-19 pandemic and, as such, reflects Rhode Island's methadone take-home policy as implemented within the broader context of the COVID-19 pandemic.

Our primary outcome was six-month retention in methadone treatment after first admission, comparing patients newly admitted during the exposed and unexposed periods. We selected a six-month window, as prior literature indicates that this duration may be considered successful retention in OUD treatment and is associated with improved long-term outcomes.³³ We defined first admission as the first recorded admission date for a given individual in BHDDH administrative records during the two time periods of interest. We defined six-month retention as six months of continuous treatment enrollment after admission date without a recorded discharge date in BHDDH administrative records, permitting seven-day gaps between discharges and subsequent admissions for patients internally or externally transferred between programs.³⁴ Due to federal regulatory requirements and BHDDH administrative oversight of all OTP data, admissions and discharges are considered complete in their recording. That is, we assume that patients without a recorded discharge date remain enrolled in treatment and are not necessarily lost to follow up.

Multivariable models were adjusted for a selection of demographic, socioeconomic, and social/structural characteristics that we anticipated may differ between the exposed and unexposed periods.^{24,35} Our analysis was restricted to the variables collected at admission and discharge. Demographic variables included:

age group (18–34 years, 35–54 years, and 55 years and older), gender (female or male, recorded as self-reported gender identity at admission with only two response options), and race/ethnicity (coded as non-Hispanic white, non-Hispanic Black, Hispanic/Latino, or other/multi-racial). Socioeconomic variables included: educational attainment (completion below high school, high-school completion, or completion beyond high school), housing status (non-institutionally housed, institutionally housed, correctionally housed, or unhoused or housed in shelter), employment status (full-time employed; part-time employed, student, or homemaker; unemployed, retired, disabled; or institutionalized), and payment source (private insurance; Medicare, Medicaid, or other public insurance; or uninsured). Social/structural variables included: veteran status (history of military service or not), referral source (self or voluntary; health care system; behavioral health system; social service or shelter; employer, school, or community service; or the criminal justice system), primary drug at admission (heroin; fentanyl; opioid analgesic or other opioid; cocaine, methamphetamine, or other stimulant; or other non-opioid drug), and whether the patient had been arrested within 30 days of the admission (yes or no). Data for covariates were relatively complete, ranging from fully complete to 6.7% missing.

Statistical analysis

First, we tabulated characteristics for patients in the cohort overall and by exposure period. Differences between exposure periods was assessed using standardized mean differences (SMDs).³⁶ Counts fewer than five were suppressed from reporting in compliance with BHDDH policy.

Second, we estimated the overall and sub-group stratified odds and risks of six-month retention after first OTP admission before and after the implementation of Rhode Island's expanded methadone access program using, respectively, logistic and Poisson regression.^{37,38} We selected the features for stratification in collaboration with BHDDH to identify those patient characteristics most salient to treatment providers. Models were adjusted for the aforementioned patient and admission characteristics using a complete case analysis with listwise deletion.³⁹ To assess model robustness to missingness, we conducted two sensitivity analyses: a range sensitivity analysis for the variable with the most pronounced discrepancy in missingness between the pre- and post-intervention periods, arrest within 30 days of admission, and an analysis using multiple imputation to correct for missingness across all variables.^{40,41} For the range sensitivity analysis, we reran our overall and stratified analyses assuming that either all participants missing in the post-intervention time period were arrested and all participants missing in the pre-intervention time period were not arrested or vice versa. For the multiple imputation, we reran our overall and stratified analyses with complete data imputed using multiple imputation with chained equations with predictive mean matching.⁴² Data management, descriptive analyses, logistic regression models, and sensitivity analyses were conducted using Stata version 16 (StataCorp LLC, College Station, TX).

Heterogeneous treatment effect-scan

Third, to assess whether any subgroups of patients were differentially affected by Rhode Island's expanded methadone take-home policy, we used the HTE-Scan machine learning approach, which is an extension of the Treatment Effect Subset Scan.⁴³ HTE-Scan iteratively searches through subgroups, defined by combinations of covariates (eg, non-Hispanic white females aged 35–54), and identifies subgroups with the most significant heterogeneity

in treatment effect, as determined by the highest value of a penalized log-likelihood ratio score. Subgroups were not compared to each other; rather, HTE-Scan analyzed the change in each subgroup's retention rate from the control to the treatment period. The log-likelihood ratio score of a subgroup S can be interpreted as a measure of how much the data in S deviates from its expectation under the null hypothesis H_0 , which is that there is a uniform treatment effect for all individuals. The alternative hypothesis for a given subgroup, $H_1(S)$, is that individuals in S experience an increased treatment effect, larger than the uniform multiplicative shift in odds observed among the treatment group. The log-likelihood ratio score $F(S) = \log(\Pr(\text{Data} | H_1(S))/\Pr(\text{Data} | H_0))$ is penalized by a constant factor (set at a value of 0.5 in this analysis) times the number of specified attribute values in the subgroup. This helps minimize the risk of overfitting the data or identifying small, uninterpretable groups. We selected 0.5 as a default value for HTE-Scan to utilize a penalty that is small but greater than zero, to avoid including irrelevant attributes that lead to overly complex subgroup descriptions, which is a risk for the unpenalized scan. However, very large penalty values would result in no heterogeneity being found. To account for differences in exposure groups in this observational study when modeling expectations under the null hypothesis, propensity weighting is used to obtain the average treatment effect on the treated (ATT). Thus, the steps for running the HTE-Scan algorithm and assessing the significance of its results are as follows:

- (1) Compute the maximum likelihood estimate of the uniform multiplicative shift in odds of the outcome under H_0 , which assumes a uniform treatment effect for individuals.
- (2) Fit a logistic regression model predicting exposure in the full dataset to obtain predicted probability of exposure for the unexposed.
- (3) Fit a logistic regression model predicting the outcome among the unexposed, weighted by the predicted odds of exposure from (2), to model the ATT.
- (4) Use the model from (3) to predict the probability of the outcome among the exposed, while incorporating the uniform shift in odds computed in (1) assumed under H_0 .
- (5) Iteratively scan across subgroups defined by their covariate profiles to identify those with the highest penalized log-likelihood ratio scores, comparing the observed outcome under exposure to the expected probability under the null hypothesis calculated in (4), penalized by the complexity parameter to minimize overfitting.
- (6) Perform permutation testing to assess the significance of discovered subgroups. For each simulation, generate a dataset with exposure status randomly permuted and rerun steps (1)–(5), obtaining the maximum penalized log-likelihood ratio score for each simulated dataset. Compare each observed penalized log-likelihood ratio score from (5) to the distribution of simulated maximum scores to determine P values; the threshold for statistical significance of 5% will be the 95th percentile of maximum simulated scores.

HTE-Scan requires the standard causal assumptions of exchangeability, positivity, consistency, and non-interference for unbiased causal inference.^{44,45} In our case, this means that effect estimates can potentially be biased by unobserved confounders that affect both selection into treatment and retention in treatment. The HTE-Scan algorithm as implemented only identifies subgroups with excessive increases in treatment effect. To explore subgroups that may have decreased retention due to Rhode Island's expanded methadone take-home policy, we re-ran the

HTE-Scan algorithm on the dataset with the retention outcome reverse-coded as discontinuation. We utilized 100 iterations of HTE-Scan for each run of the algorithm, assessing heterogeneity of the take-home policy effect across subgroups defined by gender, age groups, race/ethnicity, educational attainment, arrest within 30 days of admission, and primary drug at admission. We selected these features a priori for inclusion based on their known relevance to treatment retention and overdose risk.^{20,46,47} For significance testing, we performed a permutation test using 1000 simulations. This permutation test correctly adjusts for multiple testing, bounding the overall proportion of type-I errors (ie, the familywise error rate). The maximum subgroup score of the actual data is compared to the distribution of the maximum subgroup score for data generated under the null hypothesis of no treatment effect heterogeneity, where the same search over subgroups is used for each null dataset as the actual dataset. While this procedure is computationally expensive, multiplying the runtime by the number of simulations used for the permutation test, it is necessary to correctly adjust for the multiple testing being performed by the search procedure. To assess the sensitivity of our results to alternative penalty values, we conducted a sensitivity analysis repeating the scan using penalty scores of 0.25 and 1.00. The HTE-Scan algorithm and permutation testing was implemented using Python version 3 (Python Software Foundation, Wilmington, DE) with results summarized using R version 4.2 (R Core Team, Vienna, Austria).

Results

Sample characteristics

The cohort included 1248 patients who were newly admitted into an OTP in Rhode Island during the study time periods. Table 1 presents characteristics of admissions for the full cohort and for the pre- and post-intervention periods. Overall, most admissions were for patients aged 18–34 years (584; 47%) or 35–54 years (582; 47%), male (833; 67%), non-Hispanic white (1001; 80%), with education at the high-school level (510; 41%). Most admissions were for patients who were non-institutionally housed (717; 58%), unemployed, retired, or disabled (614; 49%), without history of military service (1171; 94%), voluntarily self-referred to treatment (1152; 92%), and not arrested in the month prior to admission (887; 71%). Most admissions were paid using public insurance (1121; 90%). The proportion of admissions recording heroin as the primary drug decreased from 64% to 46% between the pre- and post-intervention periods, while the proportion of admissions recording fentanyl as a primary drug increased from 17% to 28% between the two periods.

Figure 1 presents levels of six-month retention overall and among patient subgroups before and after the take-home methadone policy change. Overall, retention increased from 43% in the pre-policy period to 47% in the post-policy period. For most patient subgroups, changes were minor. However, among non-Hispanic Black patients, six-month retention decreased from 41% in the pre-policy period to 21% in the post-policy period, although this change was not statistically significant. Among patients with a past-month history of arrest prior to admission, six-month retention increased from 15% in the pre-policy period to 34% in the post-policy period.

Changes in six-month retention after first admission

Table 2 presents adjusted overall estimates and estimates stratified by gender, age, race/ethnicity, education, arrest history, and

primary drug at admission. These models estimated an overall adjusted odds ratio (OR) and risk ratio (RR) for the change in the odds of six-month retention after the first OTP admission between the pre- and post-intervention periods of, respectively, 1.08 (95% CI, 0.80, 1.45) and 1.03 (95% CI 0.90–1.18). Subgroup estimates generally were consistent across patient and admission characteristics, with most stratified analyses suggesting no detectable change in the odds or risks of six-month retention before and after the take-home policy intervention.

Among patients with past-month arrest prior to OTP admission, we estimated an adjusted OR of 3.91 (95% CI, 1.24, 12.37) and adjusted RR of 2.21 (95% CI, 1.07, 4.58), indicating that the odds and risks of retention among patients with recent arrest were substantially elevated in the post-intervention time period. Our gender-stratified results detected differences in the change in retention across women and men. Among women, retention decreased in the post-intervention period, with an adjusted OR of 0.62 (95% CI: 0.35, 1.10) and adjusted RR of 0.84 (95% CI: 0.67, 1.05), whereas among men, retention increased, with an adjusted OR of 1.37 (0.95–1.97) and adjusted RR of 1.13 (0.97, 1.34). Unadjusted estimates are presented in Table S1.

HTE-scan identified patient groups

Table 3 presents covariate profiles of patients identified by HTE-Scan for whom six-month retention significantly increased after the implementation of Rhode Island's expanded methadone take home policy in excess of the cohort-wide estimates. Subgroups of patients for whom retention significantly increased in excess of the overall cohort were: (1) patients with education below the high-school level who had a history of past-month arrest prior to admission ($P = 0.005$) and (2) male patients who were non-Hispanic white or Hispanic/Latino, reported heroin or fentanyl as the primary drug at admission, and had a history of past-month arrest prior to admission ($P = 0.041$). We identified overlap between clusters: 64% of the first treatment cluster were included in the second treatment cluster and 50% of the first control cluster were included in the second control cluster. Overall, 51% of the patients in the first cluster are included in the second cluster. There were no groups of patients identified by HTE-Scan whose retention was significantly decreased by Rhode Island's expanded methadone take-home policy.

Discussion

This study estimated the association of Rhode Island's expanded methadone take-home policy with changes in six-month retention after first OTP admission. We applied a novel machine learning method, HTE-Scan, to identify clusters of patients whose odds of six-month retention were in excess of (or lower than) the overall sample. Overall, we identified that the take-home policy was not associated with changes in patient six-month retention after first admission. Our assessment of heterogeneity of treatment effects identified several clusters of patients for whom retention increased in excess of the overall population, providing critical preliminary evidence on the potential benefits of the take-home policy for subpopulations at risk of overdose. Although we did not identify any clusters of patients for whom retention was significantly poorer than the overall population using HTE-Scan, descriptive analyses indicated that retention among non-Hispanic Black patients appreciably decreased. The decrease was not statistically significant due to low sample size. Racial/ethnic differences in retention should be further explored with other data that offers greater sample sizes across

Table 1. Characteristics of opioid treatment program admissions in Rhode Island, March 18-June 30, 2019 (control) versus March 18-June 30, 2020 (treatment).

	March 18-June 30, 2019 N (%) 851 (100)	March 18-June 30, 2020 N (%) 397 (100)	Overall N (%) 1248 (100)	SMD
Age group				
18–34 years	401 (47.1)	183 (46.1)	584 (46.8)	−0.02
35–54 years	392 (46.1)	190 (47.9)	582 (46.6)	0.03
55+ years	58 (6.8)	24 (6.1)	82 (6.6)	−0.03
Gender				
Female	286 (33.6)	129 (32.5)	415 (33.3)	0.02
Male	565 (66.4)	268 (67.5)	833 (66.8)	−0.02
Race/ethnicity				
Non-Hispanic White	678 (79.7)	323 (81.4)	1001 (80.2)	0.02
Non-Hispanic Black	38 (4.5)	19 (4.8)	57 (4.6)	0.01
Hispanic/Latino	117 (13.8)	43 (10.8)	160 (12.8)	−0.09
Other/multi-racial	11 (1.3)	12 (3.0)	23 (1.8)	0.12
Missing/refused			7 (0.6)	
Educational attainment				
Below high school	238 (28.0)	85 (21.4)	323 (25.9)	−0.08
Completed high school	365 (42.9)	145 (36.5)	510 (40.9)	−0.03
Beyond high school	231 (27.1)	111 (28.0)	342 (27.4)	0.11
Missing/refused	17 (2.0)	56 (14.1)	73 (5.9)	
Housing status				
Non-institutional housed	455 (53.5)	262 (66.0)	717 (57.5)	0.26
Institutional housed	48 (5.6)	22 (5.5)	70 (5.6)	−0.00
Correctional	298 (35.0)	91 (22.9)	389 (31.2)	−0.27
Shelter/unhoused	48 (5.6)	21 (5.3)	69 (5.5)	−0.02
Missing/refused				
Employment status				
Full-time	113 (13.3)	72 (18.1)	185 (14.8)	0.14
Part-time/student/homemaker	46 (5.4)	26 (6.6)	72 (5.8)	0.05
Unemployed/retired/disabled	412 (48.4)	202 (50.9)	614 (49.2)	0.06
Institutionalized	276 (32.4)	90 (22.7)	366 (29.3)	−0.21
Missing/refused			11 (0.9)	
Veteran status				
Military service history	813 (95.5)	358 (90.2)	1171 (93.8)	−0.07
No military service history	17 (2.0)	12 (3.0)	29 (2.3)	0.07
Missing/refused	21 (2.5)	27 (6.8)	48 (3.9)	
Referral source				
Self/voluntary	785 (92.2)	367 (92.4)	1152 (92.3)	−0.00
Health care			6 (0.5)	
Behavioral health	40 (4.7)	17 (4.3)	57 (4.6)	−0.02
Employer/school/community			8 (0.6)	
Criminal justice	15 (1.8)	7 (1.8)	22 (1.8)	−0.00
Missing/refused				
Arrest in 30 days prior to admission				
No	576 (67.7)	311 (78.3)	887 (71.1)	0.42
Yes	234 (27.5)	44 (11.1)	278 (22.3)	−0.42
Missing/refused	41 (4.8)	42 (10.6)	83 (6.7)	
Payment source				
Private insurance	37 (4.4)	23 (5.8)	60 (4.8)	0.07
Medicare/Medicaid/public insurance	776 (91.2)	345 (86.9)	1121 (89.8)	−0.08
Uninsured	38 (4.5)	20 (5.0)	58 (4.7)	0.03
Missing/refused			9 (0.7)	
Primary drug at admission				
Heroin	544 (63.9)	184 (46.4)	728 (58.3)	−0.36
Fentanyl	142 (16.7)	111 (28.0)	253 (20.3)	0.28
Opioid analgesic/other opioid	152 (17.9)	88 (22.2)	240 (19.2)	0.11
Cocaine/methamphetamine/other stimulant			8 (0.6)	
Other non-opioid			13 (1.0)	
Missing/refused			6 (0.5)	
Six-month retention in treatment				
No	485 (57.0)	212 (53.4)	697 (55.9)	−0.09
Yes	366 (43.0)	185 (46.6)	551 (44.2)	0.09

Abbreviations: –, denotes suppressed due to low cell size; SMD, standardized mean difference.

Percentages may not sum to 100 due to rounding.

Source: Rhode Island Department of Behavioral Healthcare, Developmental Disabilities, and Hospitals.

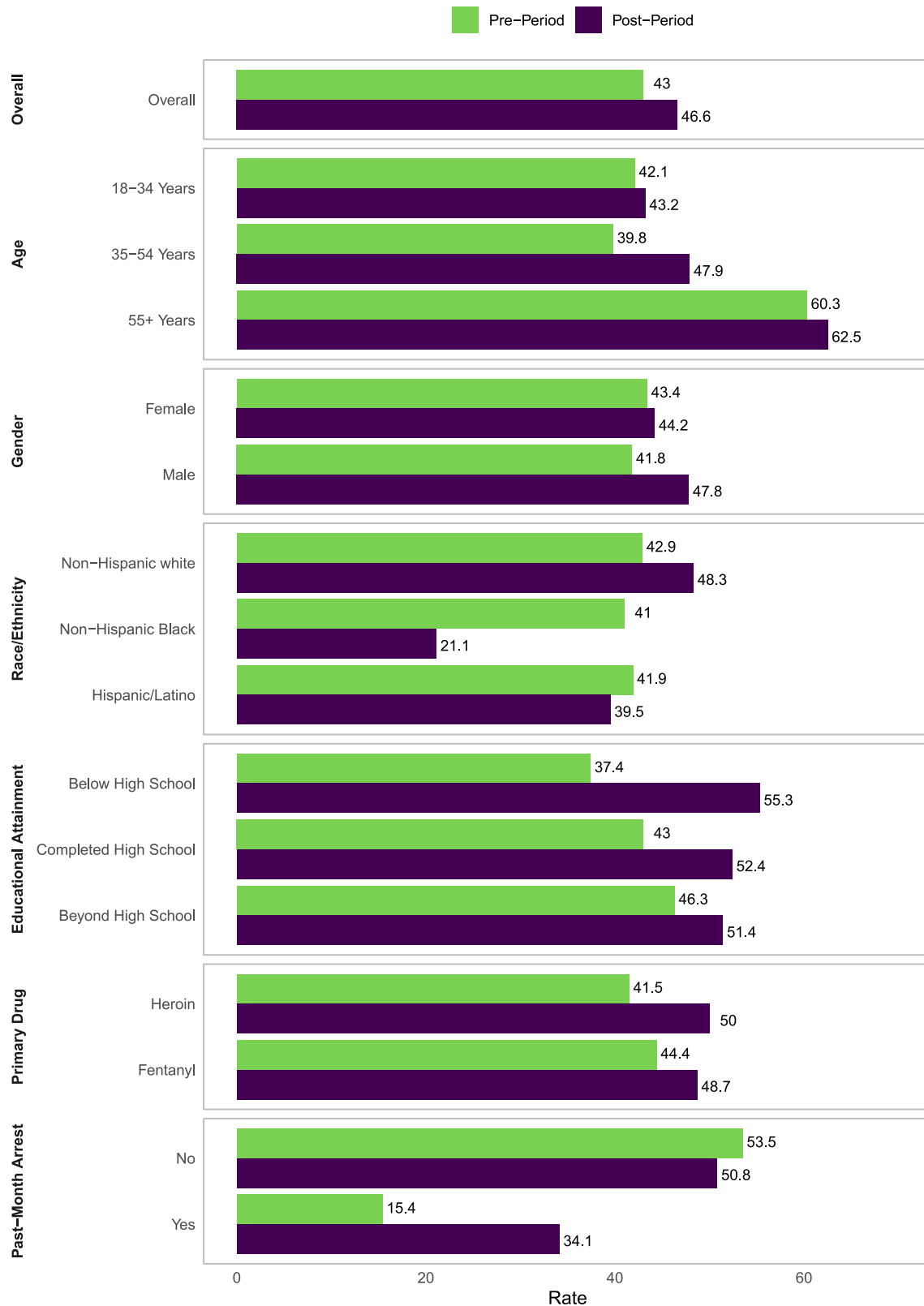


Figure 1. Retention rates in methadone treatment before and after the take-home policy change by subgroup. Pre-period: March 18–June 30, 2019; post-period: March 18–June 30, 2020. Source: Rhode Island Department of Behavioral Healthcare, developmental disabilities, and hospitals.

racial/ethnic groups. Collectively, our findings suggest that the take-home policy in Rhode Island was associated with added benefits for key subpopulations without harm to other groups.

Our findings provide state-level, population-based evidence that supplements and confirms earlier national-level findings that showed no change in OTP retention associated with the extended take-home policy.²⁴ That we identified no detectable

Table 2. Adjusted estimates for six-month retention in methadone treatment following first admission: Rhode Island, March 18–June 30, 2019 (control) versus March 18–June 30, 2020 (treatment).

	N	Adjusted OR (95% CI)	Adjusted RR (95% CI)
Overall			
Admissions			
All OTP admissions	1075	1.08 (0.80, 1.45)	1.03 (0.90, 1.18)
Stratified			
Gender			
Female	366	0.62 (0.35, 1.10)	0.84 (0.67, 1.05)
Male	709	1.37 (0.95, 1.97)	1.13 (0.97, 1.34)
Age			
18–34 years	518	0.83 (0.53, 1.31)	0.92 (0.75, 1.12)
35–54 years	485	1.35 (0.87, 2.09)	1.15 (0.95, 1.40)
55+ years	72	0.57 (0.09, 3.44)	0.80 (0.48, 1.36)
Race/ethnicity			
Non-Hispanic White	875	1.11 (0.80, 1.54)	1.04 (0.91, 1.20)
Non-Hispanic Black	47	0.25 (0.02, 3.14)	0.52 (0.21, 1.28)
Hispanic/Latino	135	0.72 (0.27, 1.90)	0.85 (0.50, 1.43)
Educational attainment			
Below high school	288	1.82 (0.95, 3.49)	1.24 (0.95, 1.62)
Completed high school	472	0.97 (0.61, 1.53)	0.99 (0.81, 1.21)
Beyond high school	315	0.96 (0.54, 1.71)	0.97 (0.77, 1.22)
Arrest within 30 days of admission			
No	830	0.96 (0.70, 1.30)	0.98 (0.86, 1.12)
Yes	245	3.91 (1.24, 12.37)	2.21 (1.07, 4.58)
Primary drug at admission			
Heroin	639	1.25 (0.82, 1.90)	1.10 (0.92, 1.33)
Fentanyl	229	1.12 (0.61, 2.07)	1.06 (0.81, 1.39)

Abbreviations: OR, odds ratio; RR, risk ratio.

Complete case analysis ($n = 1075$); additional categories not reported for race/ethnicity and primary drug at admission; all models adjusted for age group, gender, race/ethnicity, educational attainment, housing status, employment status, veteran status, referral source, past-month arrest, payment source, and primary drug, holding out stratification variable per category.

Source: Rhode Island Department of Behavioral Healthcare, Developmental Disabilities, and Hospitals.

association between Rhode Island's expanded take-home policy and changes in methadone discontinuation is suggestive that—in the context of the disruptions to the healthcare system and economic, social, and civic life during the first wave of the COVID-19 pandemic—Rhode Island's expanded methadone take-home policy may have accommodated newly admitted patients without additional disruption. Likewise, our findings are consistent with prior research that identified no population-level changes in methadone-involved overdose mortality before and after the introduction of these policies nationally.¹⁸

As states consider the ramifications of changes to methadone policy that accompanied the COVID-19 pandemic, it is crucial that policymakers foreground retention in care as an outcome. Discontinuation from methadone therapy remains the rule, not the exception, with estimated six-month retention rates ranging from 30% to 50%.^{48–52} A growing body of qualitative research has

identified that, for some patients, stringent limits on access to the medication—such as required daily visits, limited program hours, and frequent urine toxicology screening—are barriers to retention.^{53,54} Our findings provide quantitative support for the hypothesis that relaxation of methadone regulations may not adversely impact treatment retention in the United States. As retention in opioid agonist therapy is an established protective factor against overdose,⁵⁵ policies that maintain retention while promoting patient engagement should be considered as viable responses to the overdose epidemic.

Notably, our overall findings remained consistent across most patient subgroups during stratified analyses. To more rigorously assess heterogeneity in policy impact, we applied HTE-Scan to identify patient subgroups whose retention changed more than the overall cohort. We found that individuals with less than a high-school education and a history of past-month arrest had

Table 3. Heterogeneous treatment effect scan estimates for patient six-month retention following first opioid treatment program admission: Rhode Island, March 18–June 30, 2019 (control) versus March 18–June 30, 2020 (treatment).

Six-month retention after first OTP admission in excess of overall retention					
Cluster features	Treatment cluster size	Observed treatment proportion retained	Control cluster size	Observed control proportion retained	P value
Education below high school; history of past-month arrest	8	0.88	68	0.13	0.005
Male; non-Hispanic white or Hispanic/Latino; primary drug of heroin or fentanyl; history of past-month arrest	22	0.59	111	0.17	0.041

Treatment cluster indicates patients admitted from March 18–June 30, 2020; control cluster indicates patients admitted from March 18–June 30, 2019.

Source: Rhode Island Department of Behavioral Healthcare, Developmental Disabilities, and Hospitals.

significantly greater odds of retention in the post-policy period. This suggests that expanded take-home policies may confer particular benefit to patients with intersecting structural vulnerabilities—such as low educational attainment and recent criminal legal involvement—who prior studies have shown to be barriers to methadone access and retention.^{56,57} Rather than being excluded from reform efforts, these findings imply that such patient subgroups may stand to gain the most from policy changes that reduce logistical and institutional barriers to care. As jurisdictions evaluate implementation of expanded methadone access, these subgroup insights could inform the tailoring of interventions to reach and retain historically marginalized patients within opioid treatment systems.⁵⁸ We identified that 51% of individuals in the first HTE-Scan cluster were also included in the second cluster, indicating that while these clusters capture distinct patient characteristics, they are not entirely independent. Given the overlap between clusters, our findings do not necessarily indicate that patients in the second cluster experienced a retention benefit above and beyond the first group. Rather, it suggests that HTE-Scan detected another subset of the population for whom the policy was particularly impactful.

Crucially, these results do not directly test for sex differences in policy impact. However, the composition of the second cluster suggests that non-Hispanic white or Hispanic/Latino females with heroin or fentanyl use and past-month arrest did not experience a large enough increase in retention to be included in the cluster. This does not necessarily mean that women in this subgroup had no increase in retention, but rather that their increase did not meet the HTE-Scan significance threshold for clustering. Overall, Figure 1 indicates that retention among women increased slightly (from 43.4% to 44.2%), but the magnitude of this increase was notably smaller than among men (41.8% to 47.8%). After adjustment for arrest and other covariates, the estimated odds and risk of retention among women declined (adjusted OR = 0.62; adjusted RR = 0.85), suggesting that this apparent stability may be compositional in nature. These findings raise important questions about whether expanded take-home policies equitably supported retention for all groups and suggest that further attention to gender-specific barriers to methadone engagement is warranted. Future research should further explore differential barriers to methadone access and retention among women to identify gender-specific needs and differences and ensure that novel treatment policies are implemented equitably.^{59,60}

Furthermore, although these clusters were small, they suggest that the expanded take-home policies may differentially benefit those patients with key risk factors for discontinuation and overdose: criminal legal system involvement and low socioeconomic status as measured through educational attainment.^{35,61} Notably, HTE-Scan did not identify any subgroups of patients whose retention was significantly poorer than the overall. This is both consistent with our overall findings that the policy was not associated with poorer outcomes overall, and suggestive that the policy, as implemented in Rhode Island, was not harmful to patient subgroups. Instead, expanded methadone access policies may promote health equity for populations with OUD by increasing retention among those groups at high risk for discontinuation, including people with a prior arrest history and people with low socioeconomic status. Given the overlap of the clusters that we identified, we interpret these results as complementary rather than strictly separate, reinforcing the potential importance of recent criminal legal involvement in driving retention effects. Overall, our findings using HTE-Scan both demonstrate the application and utility of this novel approach to the

assessment of heterogeneity in epidemiologic research, while informing the implementation of expanded methadone access policies in Rhode Island and the United States.

Furthermore, our descriptive analysis identified that the proportion of admissions increased slightly between the pre- and post-intervention periods for non-Hispanic White patients but remained stable for non-Hispanic Black patients and decreased slightly for Hispanic/Latino patients. Although we identified no subgroups with statistically significant decreases in retention, retention among non-Hispanic Black patients decreased from 41% to 21% between the study periods, while retention among non-Hispanic white patients increased from 43% to 48% between the periods. This may suggest latent racial disparities in the benefits accrued from substance use policy reforms.⁶² Prior work has demonstrated racial disparities in the use of methadone take-home policies, with non-Hispanic Black Medicare beneficiaries nationally 20% less likely to use take-home methadone than non-Hispanic White beneficiaries.⁶³ Our descriptive findings are consistent with these and other studies demonstrating inequitable implementation of substance use policies.

Non-Hispanic Black and Hispanic/Latino patients were underrepresented in our sample by the Rhode Island population. Non-Hispanic Black and Hispanic/Latino patients comprised 4% and 13% of our sample, respectively, despite comprising 9% and 17% of the Rhode Island statewide population.⁶⁴ Future work should consider strategies to bolster structurally competent patient engagement in care,⁶⁵ particularly in light of increasing rates of overdose deaths among non-Hispanic Black populations in Rhode Island and nationally.^{66,67} Likewise, our findings using HTE-Scan identified a cluster of non-Hispanic white and Hispanic/Latino patients who experienced six-month retention in excess of the overall sample; no such clusters were identified for non-Hispanic Black patients. Additional research is needed to understand how specific patient populations received and adapted to expanded take-home policies, as well as whether expanded access policies were implemented uniformly across subgroups by clinical providers.

Limitations

This study has several limitations. First, BHDDH records contain comprehensive dates of OTP admissions and discharges but limited information about the quality of care, and how or why patients discontinued treatment. Second, while all patients initiated OTP during the observation period, it is possible that some had entered and exited OTP prior to the study. However, given our original look-back period of January 1, 2016, over three years prior to our observation start date for our main analysis, we assume that left censoring is not a major cause for concern. Despite this, as many individuals with OUD cycle in and out of treatment, future research leveraging longitudinal administrative data could help determine whether prior treatment experience influences retention outcomes under expanded take-home policies. Third, our study was restricted to Rhode Island and assessed the change in OTP retention before and after the enactment of the expanded take-home policy without a true control group. Thus, we are unable to interpret estimates as causal. Fourth, our study relied on administrative admission and discharge data to assess retention but does not include direct measures of opioid use, such as urine toxicology screening or self-reported substance use. Future research incorporating these measures is needed to evaluate whether expanded methadone take-home policies influenced continued opioid use during treatment and other patient-centered outcomes to better understand patient engagement beyond retention. Fifth, we estimated the short-run odds of

OTP retention associated with a single policy enacted at the start of the COVID-19 pandemic in the United States (March 2020), a time when the national health policy landscape was in flux. Thus, our findings reflect the impact of expanded methadone take-home policies as implemented within the broader context of the COVID-19. While our study suggests that the policy did not negatively impact retention overall, we cannot disentangle its effects from other pandemic-related disruptions in healthcare access and social conditions. Some subgroups may have experienced lower retention during this period due to factors beyond the policy itself, highlighting the need for further research on the long-term effects of these regulatory changes in non-crisis contexts.

Sixth, the clusters identified through our application of HTE-Scan were small in size. This may be due to two factors: (1) the overall year-on-year reduction (by a factor of 2×) in opioid treatment program admissions; and (2) the year-on-year reduction (by a factor of 2.5×) in the proportion of individuals arrested in the 30 days prior to admission. However, since the control observations are used to model the expected retention rate in the treatment group under the null hypothesis of no treatment effect, the larger control group size makes our estimates of expected retention rate more reliable. Despite these larger control clusters, the small treatment cluster sizes decrease statistical detection power, and thus a small treatment cluster will only be detectable if it has a large difference in retention rate as compared to its corresponding control cluster. Seventh, while HTE-Scan identified two distinct clusters of patients with increased retention, we observed substantial overlap between them, with 51% of individuals in the first cluster also included in the second. This overlap suggests that the identified subgroups are not entirely independent, and while they highlight key patient characteristics associated with increased retention (ie, recent criminal legal involvement), they should be interpreted as complementary rather than strictly separate groups. In sum, while hypothesis generating, our findings regarding heterogeneity in OTP retention should be confirmed through further studies.

Conclusions

This study estimated changes in six-month OTP retention after a first admission in Rhode Island associated with the state's COVID-19 expanded methadone access policy. We found no overall association between six-month retention and the policy. This finding was consistent across nearly all patient sub-populations, suggesting that the policy may not have disrupted patient care during that early crisis period. We identified two patient subgroups, both with criminal legal involvement, for whom the policy may have been differentially beneficial. Future research is needed to assess associations between expanded methadone access policies and other outcomes, including overdose risk, to inform policymakers as these newly permanent changes to methadone regulations are implemented nationwide.

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Supplementary material

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Conflict of interest

The authors report no conflicts of interest.

Data availability

The data used in this study are not available due to data use restrictions established with the Rhode Island Department of Behavioral Healthcare, Developmental Disabilities, and Hospitals. Analysis code is available on GitHub: <https://github.com/danielbneill/aje2025>.

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