Medications for Opioid Use Disorder in Minnesota Prisons and its Effects on Recidivism and All-Cause Mortality

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Research Summary

Across the United States, a significant proportion of people in jails and prisons suffer from some form of substance use disorder. In recent years, opioids have become a concern as the country has entered an epidemic in which opioid overdoses occur with relative frequency. Given that drugs have a significant impact on all aspects of crime, some jails and prisons in the U.S. have started implementing medications for opioid use disorder (MOUD) programs to, one, save lives, but also help address one criminogenic need associated with criminal behavior. This study used a retrospective quasi-experimental design to generate a comparison group (357 incarcerated persons) to a group of individuals who received treatment for opioid use disorder (357). Using competing risks models, results provide evidence that MOUD does reduce recidivism among those who have received it. Results also suggest that when, paired with traditional substance use disorder treatment, MOUD can have a somewhat higher magnitude of effect. These results suggest that the use of MOUD should be expanded across the U.S.

Introduction

The use of illicit substances, such as opioids, have had a substantial impact on the criminal justice system. Across the U.S., 58% of people incarcerated in state prisons and 63% of those held in jail suffer from an abusive or dependent relationship with drugs and/or alcohol (Bronson et al., 2017; Clark, 2024). In fact, these substances have a role in the sanctioning of most people who are in federal, state, and local carceral facilities (National Center on Addiction and Substance Abuse, 2010). This issue has direct implications for both public health and public safety. Medications for opioid use disorder (MOUD) have shown effectiveness in the reduction of cravings, the use of illicit opioids, and individual stays in treatment (Pew, 2020). MOUD is now considered the "gold standard" when addressing opioid use disorder (OUD; Homens et al., 2023). Therefore, it has started to be employed in some correctional facilities across the U.S. Despite the success in the community MOUD has enjoyed, Maruschak et al. (2021) reported that about one percent of people incarcerated in state and federal prisons received MOUD.

Where there has been implementation, relatively few (14) states offer what would be considered comprehensive MOUD services at either intake or release in many of their jails and prisons, as of 2023 (Homans et al., 2023). Furthermore, the effectiveness of MOUD in the reduction of recidivism has received mixed support. In addition to examining the risk of recidivism for incarcerated persons, there is a question of how engagement in MOUD for these individuals plays a role in mortality. Thus, the current study expands upon the literature related to MOUD within carceral settings and its effects on mortality and recidivism. More specifically,

is MOUD effective in reducing recidivism and mortality among those who are incarcerated?

What are Medications for Opioid Use Disorder?

Prior to delving into the literature on the effectiveness of MOUD, it would be beneficial to briefly discuss what medication-assisted treatment is and the vectors through which it is traditionally delivered. Medications for opioid use disorder have been a key component for the treatment of opioid use in the general population and consists of administering medications, such as those outlined below, which either blunt or block the effects of opioids and/or reduce the cravings for and withdrawal from their use (Farré et al., 2002; Moore et al., 2018; 2019).

Currently, there are three accepted methods through which MOUD is delivered; methadone, buprenorphine, and naltrexone (Farré et al., 2002; Gordon et al., 2017; Moore et al., 2019). Traditionally, methadone has been the primary method for treating opioid use disorder (Moore et al., 2019). Methadone maintenance is delivered orally and requires daily dosage, at least initially (World Health Organization, 2009; Moore et al., 2019). Methadone works by blunting or blocking the euphoric effects associated with use of illicit opioids as well as providing a reduction in the cravings one feels and the effects associated with withdrawal (SAMHSA, 2024).

Buprenorphine is a second and more recent form of MOUD which was approved by the Food and Drug Administration for use to treat opioid dependence in 2002 (Gordon et al., 2014; Moore et al., 2019) and can be dosed on alternating days either orally with tablets or dissolvable film, subcutaneously with an injection, or via a subdermal implant (Center for Drug Evaluation and Research, 2023). Unlike methadone, buprenorphine does not blunt or block the effects of opioids, it suppresses or reduces cravings (SAMHSA, 2024).

Both methadone and buprenorphine are known as agonists, the former being a full opioid

agonist and the latter being a partial agonist (Farré et al., 2002; Otiashvili et al., 2013; Marsch, 1998). Essentially, this means that treatments, while being effective for opioid dependence, have the potential for addiction as well (Hyatt & Lobmaier, 2020). Alternatively, the most recent medication used in the treatment of OUD is naltrexone, also known by its brand name, Vivitrol, has no addictive potential (Hyatt & Lobmaier, 2020; Moore et al., 2019). Naltrexone is an antagonist which binds to the receptors that produce the euphoric sensation elicited by opioids, thereby blocking the sensation as well as the sedative effects of these substances (SAMHSA, 2024). It has the added benefit that its dosage is only once every 4 weeks via an intramuscular injection, the oral route, or by implant (Center for Drug Evaluation and Research, 2023; Hyatt & Lobmaier, 2020). Injections and implants also allow for the prevention of the diversion, or the illegal distribution/abuse of prescription medications, of other forms of MOUD like methadone and orally administered buprenorphine. The utilization of these forms of substance use disorder (SUD) treatment is not common in jails and prisons across the U.S. as corrections practitioners have been reticent to adopt this modality of treatment. Some analyses have suggested that funding, misconceptions/stigma about the role of carceral facilities in MOUD, OUD and MOUD in general, staffing issues, issues related to education and technical assistance, and questions around potential diversion of medication have influenced stakeholder decisions whether to implement MOUD (Neal et al., 2019; Shenkar, 2018; Sullivan-Congden 2022). Because of low adoption rates of MOUD, the breadth of literature on the effectiveness of MOUD in carceral settings and its effects on recidivism is limited.

Best Practices in Comprehensive MOUD

For MOUD to be successful, it is suggested that it be paired with several other evidence-based practices. First, all participants should be screened for SUDs by staff who are qualified to

assess and diagnose use disorders (Homans et al., 2023). Second, treatment should include withdrawal which is medically managed as well as counseling in the form of cognitive behavioral therapy (CBT). Effective programs should offer the provision of housing that is supportive in which incarcerated persons receiving treatment are separate from the general population in jail/prison to promote a rehabilitative environment. A fourth best practice is forging relationships with community partners who provide MOUD as aftercare (CCHCS, 2022; Scott et al., 2022). Effective MOUD programs should also give assistance to those suffering from SUDs with their applications for Medicaid and other forms of insurance coverage as well as giving enhanced reentry services which can assist with overdose prevention, such as providing naloxone at release (CCHCS, 2022; Homans et al., 2023). In addition, pairing MOUD with SUD treatment may also be an effective practice as they can incorporate many of the above factors. For example, most SUD programs are based in CBT. SUD treatment programs may also employ aftercare (e.g., follow-up care), providing resources to their clientele to support the maintenance of their sobriety. Programs that follow clients from institutions to the community have been evidenced to provide positive outcomes for reducing reoffending (Andrews, 2000; Listwan et al., 2006).

MOUD and Recidivism: Does it Work?

Methadone

Within this limited body of literature, many early studies of MOUD examined the effects of methadone on recidivism and adopted an observational approach. This makes sense given methadone is the longest and most used form of MOUD for OUD inside and outside of carceral settings (Gordon et al., 2008; Kinlock et al., 2009; Moore et al., 2018; 2019). Dole et al. (1969) found that of those who were inducted into a methadone treatment regime before they were

released exhibited reduced rates of incarceration in their follow-up period of 7-10 months. Bellin et al. (1999) found that those who received higher doses of methadone prior to release (≥60mg) were at reduced risk of reincarceration compared to their low dose (≤30mg). Additionally, the high dose group had longer times to reincarceration relative to incarcerated persons who received methadone for detoxification only and those who received no methadone. However, the high dose group were at higher risk of recidivating relative to the above comparison groups. Similarly, Westerberg et al. (2016) found that incarcerated persons who continued methadone management treatment while incarcerated experienced longer times to rebooking than those who suffered from a SUD but only received palliative medication when they were incarcerated. Westerberg and colleagues also found significant reductions in criminal behavior after re-entry, although there was no difference when compared to those who were incarcerated and did not receive methadone. Magura et al., (1993) did not find any difference between incarcerated persons who received methadone and those who did not regarding property offenses or having recent illegal income at 6.5 months after being released. But they did find that individuals who received treatment were more likely to seek MOUD after release and saw lower drug use as well as crime.

For male heroin users in Australia, individuals who received methadone maintenance treatment also saw reduced risk of reincarceration (Dolan et al., 2005). Farrell-MacDonald et al. (2014) examined the effects of methadone on women who had been incarcerated and suffered from SUD in Canada. The participants were split into three comparison groups, those who were continuing methadone treatment, those who terminated treatment, and those who suffered from SUD but did not receive methadone treatment (Farrell-MacDonald et al., 2014). Relative to those who did not receive treatment, those who continued treatment had a 65% lower risk of returning to custody. MacSwain et al. (2014) also found that relative to those who terminated their

methadone treatment, those who continued treatment post-release saw significantly lower return to custody rates.

Buprenorphine

Compared to methadone, the use of buprenorphine as a medication for treating OUD is more recent and has received less attention in the literature. Albizu-Garcia and colleagues (2007) found that within their study of 45 male incarcerated persons in Puerto Rico, there was some evidence that persons who completed MOUD saw a higher magnitude of effect on crime and were less likely to less likely to use drugs. However, this study has limited generalizability and a small sample along with a short follow-up period of just one month. Similarly, Zaller et al. (2013), in a feasibility study, used a sample of 44 participants who received buprenorphine either after being released or while incarcerated. Participants who began MOUD while incarcerated were re-arrested more than the group who were started on treatment post-release. Although, those who were not in treatment after release during the 6-month follow-up period were more likely to report being re-arrested. Much like the work of others, Zaller's is also limited by a low sample size and limited generalizability.

In a study which examined all adults with OUD in two separate Massachusetts jails, one which had 469 persons that received MOUD while the other had 272 who did not, there was support for the supposition that buprenorphine is effective in reducing recidivism (Evans et al., 2021). Indeed, in their 1- to 4-year follow-up period, those who received buprenorphine while incarcerated had an average of 132.9 days after release until a new arraignment, re-incarceration, or probation violation whereas those who did not receive the intervention had an average of 129.4 days. Incarcerated persons who were given buprenorphine saw an overall 29% reduction

in recidivism risk compared to the non-treated group (Evans et al., 2021).

Naltrexone

Out of the three FDA-approved MOUD medications, naltrexone has received the least amount of attention regarding incarcerated persons and recidivism but is also the most recently approved form of MOUD (2010; Srivastava & Gold, 2018). In an open-label trial, that randomly assigned 46 participants to either a naltrexone or methadone group, Lobmaier et al. (2010) provide some evidence that naltrexone was related to a significant reduction in criminal activity and drug use after release. However, there was no significant difference between the naltrexone and high dose methadone comparison groups. Finally, when compared to a "treatment as usual" control group, Lee and colleagues (2015) were unable to find support for a reduction in reincarceration in the naltrexone treatment group. Although, when participants received 2 injections, they had fewer reincarcerations than those who received 1 in their 6-month follow-up.

General Studies of MOUD

The work of Lee and colleagues (2015) was not the only examination of MOUD which did not demonstrate a significant reduction in recidivism among those who received methadone, buprenorphine, or naltrexone. In a series of randomized control trials from Gordon and colleagues (2008; 2014; 2017; Kinlock et al., 2009) examining continuation of treatment and subsequent use of heroin after being treated with methadone or buprenorphine, the researchers found that persons who received MOUD in these forms were more likely to seek community-based treatment once released. However, formerly incarcerated persons who received MOUD did not see better outcomes relative to the control group where heroin and cocaine use were concerned, nor was there a significant effect related to criminal behavior at either 6- or 12-

months post release.

Between 2012 and 2024, there have been three meta-analyses and one systematic review of MOUD research, each having varying inclusion/exclusion criteria. The earliest of these, a systematic review from Hedrich et al. (2012), found that the effects of MOUD are "equivocal" in that some studies showed effects and others did not. Moore et al. (2019), in their meta-analysis of randomized control trials, did not find support for MOUD reducing the risk of recidivism for those who participate in this form of treatment. Further, another, more recent meta-analysis, which was more inclusive, also failed to find support for this idea regarding reincarceration and rearrest (Strange et al., 2022). The most recent meta-analysis, however, provided evidence which suggests MOUD, not only, reduces reincarceration but also drug use and increases treatment engagement after being released (Boksán et al., 2022).

Overall, the literature provides mixed evidence on the effectiveness of MOUD, regardless of whether the treatment is methadone, buprenorphine, or naltrexone regarding recidivism (Mitchell, 2022; Moore et al., 2019; Strange et al., 2022). This may be due to differential operationalization of recidivism and a large range of follow-up periods (1-month to 4 years) across these studies. Although evidence suggests that those who continue community based MOUD do see decreased recidivism (Moore et al., 2019). Additionally, many of these studies are limited by their sample sizes and generalizability. There is also the issue of many studies using self-reports as their mechanism for collecting outcome data on recidivism. In total, research seems to suggest that continuity of care (i.e., aftercare) is important once an incarcerated person re-enters their community as desistance from OUD treatment post-release seems to have

potentially deleterious effects (Mitchell, 2022; Moore et al., 2019; Strange et al., 2022).

Mortality and MOUD

It is well documented that people who are formerly incarcerated suffer from poorer health and mortality outcomes than those who have not been incarcerated (McNeeley et al., 2023). Correctional literature has demonstrated that previously incarcerated persons suffer from premature death at higher rates than the general public (Binswanger et al., 2007; Fazel & Baillargeon, 2011; Massoglia & Pridemore, 2015; Massoglia & Remster, 2019; Schnittker & John, 2007). Further, studies have identified drug overdose as the number one cause of death among people who were previously incarcerated (Binswanger et al., 2007; 2013). Thus far, MOUD has enjoyed a significant amount of success in curbing mortality in the broader literature. For example, in a meta-analysis of MOUD research, Ma et al. (2019) found evidence that MOUD significantly lowered all-cause and overdose mortality compared to those who did not receive the intervention. However, within literature specifically related to MOUD in carceral settings, less attention has been given to the effectiveness of this intervention on the mortality of incarcerated and formerly incarcerated persons.

Some studies that have examined the effectiveness of MOUD in correctional settings have examined both recidivism and mortality outcomes. For example, in their four-year follow-up study, Dolan and colleagues (2005) found that all-cause mortality risk was sixteen times higher outside of prison than inside, however, there was no significant difference between those who received MOUD and those who did not. On the other hand, Hedrich et al (2012), reported they were able to find a single randomized control trial which reported death data and that it suggested lower mortality after release for those who received MOUD. However, upon inspection, Kinlock et al. (2007), cited by Hedrich and colleagues, did not use any rigorous

analysis to support this argument, they only reported that a single overdose death was recorded in their sample during their one-month follow-up period. Haas et al. (2021) did not find any significant difference between control and treatment groups for fatal overdoses in their multi-year study of methadone treatment in Connecticut jails. Similarly, Strange and colleagues' (2022) meta-analysis did not demonstrate support for MOUD lowering risk of fatal overdoses. Notably, both studies from Haas and Strange demonstrated reduced risk for non-fatal overdoses.

Other literature would suggest that MOUD may provide better outcomes regarding mortality and other adverse events. In Lee et al.'s (2015) small pilot study, there were no reported adverse events in their follow-up period, which included overdose or death. However, given the lack of variance, there is no way to determine whether there was a significant difference between the treatment and control groups. In two studies within the United Kingdom, Bird et al., (2015) and Marsden et al., (2017) both found significant decreases in the risk of death for those who received opioid substitution treatment. Within Bird's study, drug related deaths significantly dropped from 3.8 per 1,000 releases in the pretreatment period to 2.2 per 1,000 in the post treatment period in their twelve-week follow-up. Marsden and colleagues (2017) reported a reduced risk of all-cause mortality and "drug-related poisoning" between 75 and 85% for those who received MOUD while incarcerated in their first month post-release. However, after one month, there was no difference for the intervention and control groups. Similarly, Degenhardt et al. (2014) supported a decrease in risk of death one month after release of 75%, although they also found that the effects of receiving treatment prior to re-entry provided protection that quickly decayed in time.

Much like Marsden, Lim and colleagues (2022) provided evidence that having received MOUD while incarcerated reduced risk of overdose death by 80% and reduced all-cause

mortality by 78% within 1 month and 71% within 2 months after release from New York jails. In a study which utilized a microsimulation model that simulated 55,000 persons who were at risk of overdosing on opioids in Rhode Island, Macmadu et al. (2021) found that the provision of methadone, buprenorphine, and naltrexone had a higher magnitude of effect on reducing overdose deaths in a population that is at risk than a naltrexone-only intervention. Moreover, compared to typical care, naltrexone alone produced a reduction in overdose mortality by 22.8% while provision of all three forms of MOUD produced a reduction of 31.6% for those who had been incarcerated in the prior year over the eight-year simulation period. The most recent evaluation of MOUD in correctional settings on mortality suggests that much like recidivism, aftercare is important. Pourtaher et al. (2024) found that not only were mortality outcomes better while incarcerated for participants of a New York state MOUD program, but for those who picked up their buprenorphine prescription after release, there were fewer opioid-related deaths than those who did not continue treatment once released.

Similar to studies that have examined the effects of MOUD on recidivism, studies of the relationship between MOUD and mortality have been methodologically weak, resulting in mixed results. Many of these studies used small samples, observational designs, or were confined to comparing specific jails/prisons, thus leading to limited generalizability. To overcome the limitations of previous studies, this study used multiple measures of corrections based MOUD, multiple recidivism outcomes (supervision revocations, re-arrests, new convictions, and new offense reincarcerations) as well as post-release mortality, coupled with a large sample of incarcerated persons who have been treated in Minnesota prisons for OUD and official data related to our outcomes. Furthermore, we used propensity score matching (PSM) to limit selection bias and create control and treatment groups which are comparable on several key

variables. Our PSM process is described in more detail in the methodology.

MOUD in Minnesota Prisons

The Minnesota Department of Corrections' (MnDOC) MOUD program began in 2015 and offers both continuation and initiation of MOUD for its incarcerated population. While MnDOC is not authorized to provide methadone treatments, it does provide buprenorphine for incarcerated persons and naltrexone to those who are being released. According to the guidelines for the administration of this program, the provision of MOUD is limited to individuals who have six months or less of time to serve in a MnDOC facility (MnDOC, 2021). Although, incarcerated persons may be inducted closer to their release if they are serving longer periods of time. The inclusion criteria for continuation require that the incarcerated person must have been prescribed buprenorphine within the previous two-weeks from a verified prescriber and have an OUD diagnosis which has been documented. Additionally, they cannot, at the time of intake, be experiencing acute intoxication from any substance, and they must have arranged care in a treatment facility which accepts MOUD or have a close follow-up with a buprenorphine provider.

When an incarcerated person seeks to be inducted to MOUD, they must have a diagnosis of moderate to severe OUD per the Diagnostic and Statistical Manual of Mental Disorders, version 5 (DSM-V) or have at least six to five weeks until their scheduled release date. At intake, the incarcerated person should demonstrate evidence of active withdrawal, which is based upon a standardized clinical measurement of withdrawal symptoms. Alternatively, they need to be past acute withdrawal. For heroin and other short acting opiates, the first dose of MOUD may be provided 12 hours after their last dose or 24 hours for longer acting formulations. If the person had previously been treated with methadone, a first dose of buprenorphine will not be

administered for a minimum of 36 hours but may be as long as 72 hours from their last dose. For those who are incarcerated having been on methadone, they are transitioned off that medication and transitioned to buprenorphine, if they elect to do so.

At present, the MOUD program within MnDOC does not provide continuous treatment in the sense that someone cannot be given long-term treatment. For example, someone who is admitted to a Minnesota prison who is seeking continuation of MOUD would be tapered off if they have more than six months to serve. They would potentially be eligible for induction closer to release, if they want to restart treatment.

Methodology

This study utilized a quasi-experimental retrospective design to evaluate the effectiveness of carceral MOUD on recidivism and mortality for those who were part of the treatment program. Recidivism and mortality outcomes for those who received MOUD were compared against the outcomes of a matched set of non-participants. The dependent measures include recidivism and mortality. Recidivism data were derived from Corrections Operations Management System (COMS; supervision revocations and new offense reincarcerations) and the Bureau of Criminal Apprehension (re-arrests and new convictions), while data on mortality were provided by the Minnesota Department of Health, which included the date and cause of death. People in both treatment and control groups were released from prisons in the state of Minnesota between 2015 and 2021 with a follow-up period extending up to early May 2024.

In total, there were 359 participants released from prison who were in the MOUD program over the study period. There were 27,718 individuals released from Minnesota prisons during the same period. From these releasees, we filtered out incarcerated persons who did not have an OUD diagnosis. This netted 3,008 releasees that were the pool from which we generated

a control group. The process for matching these cases will be described in greater detail later in this section.

Dependent Variables

The outcomes of interest in this research are recidivism and mortality. More specifically, we examine supervision revocations, re-arrests, new offense reincarcerations, and new felony convictions. Recidivism events were tracked to the date on which the data were pulled and allowed for at least two and a half years of follow-up time. On average, members of the study had an average of 34.18 months or 2.85 years of follow-up for recidivism outcomes (range 0 to 78 months) and 45.67 months or 3.81 years for all-cause mortality (range 0 to 102 months).

Survival analysis (Cox regression) and the Fine-Gray models for competing risks (Fine & Gray, 1999) were used to estimate the effect of the MnDOC's MOUD program on the outcomes of interest. These forms of modeling are preferred as they use the available time and status data and make determinations about whether an event occurred, how soon they occurred after release, and indicate if the event occurred during the follow-up period. Time to event variables were calculated by taking the difference in months between the incarcerated person's release date and recidivism date or mortality date. For those who "survived" the follow-up period, the date three years post-release was calculated, if the end date was in the future, the date was changed to coincide with the date data were pulled. After this, the difference, in months, between the follow-up period end date and release date was calculated.

For the competing risks models, the months to any form of recidivism and mortality were combined such that, a person who recidivated had that time recorded or, if they died during the study period before a recidivism event, time to mortality was recorded. For all those who completed the study period without dying or recidivating, their time was recorded months to the

end of the follow-up period from release. Competing risks modelling provides a more granular analysis of time to event data where a person may be prevented from completing the study period because of an event which precludes them from doing so (Zhang, 2017). In the case of this study, an individual cannot recidivate if they expire beforehand.

Independent Variables

The Behavioral Health Services unit within MnDOC tracked which incarcerated persons participated in MOUD and their dosage. Further, the type of treatment was tracked given incarcerated persons had the potential to receive buprenorphine (Suboxone) or naltrexone (Vivitrol). Our primary independent variable measures whether someone received either medication for treatment. We also had variables that indicated the specific medication received. In total, there were 359 recipients of either of these forms of MOUD, 299 of which received Suboxone and 69 received Vivitrol. Furthermore, within our matched sample, there were 19 cases in which an individual expired from either natural or unnatural causes. Of those who were deceased, 9 had received MOUD while incarcerated.

Other control variables used in the analyses were drawn from COMS. These measures include demographic information such as gender, race/ethnicity, age, and education; criminal history data such as number of prior incarcerations; risk of recidivism (as measured by the MnSTARR, Duwe & Rocque, 2021); and information on the incarcerated person's most recent prison stay, such as misconduct, length of stay, and participation in traditional SUD treatment.

PSM

This study employed PSM to match non-treated individuals to treated individuals. This is a process in which a logistic regression is used to estimate a propensity score to receive MOUD for any eligible incarcerated persons (Rosenbaum & Rubin, 1985). Presented in Table 1, MOUD

was the dependent variable (0 = no treatment, 1= Received Suboxone and/or Vivitrol), along with several variables which are assumed to be related to selection for treatment as independent variables. Part of the matching procedure is to first use logistic regression to model the propensity of each person to begin the MOUD program for all eligible persons (Rosenbaum & Rubin, 1985). Table 1 presents the logistic regression analysis where MOUD participation was the dependent variable (0 = no participation; 1 = MOUD participation), and several variables which were thought to be associated with selection into the MOUD program being used as independent variables.

Table 1. Logistic Regression Model for MOUD Program Selection

Predictor	*Predictor Description*	*Odds Ratio*	*Standard Error*
Received SUD Tx	Received substance use disorder treatment while incarcerated = 1; No = 0	1.890***	0.128
MnSTARR Risk Level	Risk level for incarcerated person; Low = 1; Very High = 4	1.173*	0.082
Positive Diagnostic	Pos. Diagnostic = 1; Neg. Diagnostic = 0	0.818	0.226
Discipline	Number of disciplinary actions for current stay	1.001	0.010
Age at Release	Age (measured in years) at date of release from prison	0.995	0.008
Racial/Ethnic Minority	Racial or ethnic minority = 1; white/non-Hispanic = 0	0.772**	0.118
Length of Stay	Number of months between prison admission and release dates	0.964***	0.007
Prison Admissions	Number of prior prison admissions	0.934**	0.025
Total Convictions	Number of total convictions	1.000	0.007
Offense Type:			
Drug Offense	Drug offense = 1; non-drug offense = 0	1.184	0.190
DWI Offense	Felony DWI offense = 1; non-felony DWI offense = 0	1.631	0.292
Person Offense	Person Offense = 1; non-person offense = 0	0.969	0.196
Property Offense	Property offense = 1; non-property offense = 0	1.217	0.208
Sex Offense	Sex offense = 1; non-sex offense = 0	1.291	0.299
Intercept		0.126***	0.434
N		3,367	
Log Likelihood		2201.673	
Nagelkerke R^2		0.050	

Note: *** $p < .001$; ** $p < .01$; * $p < .05$

The odds ratios presented in Table 1 suggest that the single most prevalent predictor of engaging in MOUD treatment was having received SUD treatment (OR = 1.890; $p \leq .001$). Recidivism risk also increased the odds that an incarcerated person participated in MnDOC's medication-assisted treatment program (OR = 1.173; $p \leq .05$). Being a member of an ethnic or racial minority group decreased the odds that someone would participate in the MOUD program by 22.8% (OR = .772; $p \leq .01$). Similarly, the number of prison admissions and the length that a person was incarcerated also reduced the odds of participating in MOUD. The result for time in prison stands to reason given the current MnDOC guidance requires a stay of 120 days or less, although there is some flexibility.

The propensity scores generated by the analysis for those in the sample were subsequently used to match MOUD participants to those who did not participate. We used a "greedy" without replacement matching procedure to perform the matching of cases. Essentially, MOUD participants were matched with their "nearest neighbor" with a caliper of 0.10.[1] Of the 359 total MOUD participants, all but two were matched. The resulting sample includes 357 MOUD participants and 357 non-participants. The bias reduction results from this can be seen in Table 2.

Given the results presented in Table 2, our matching process generated more balanced treatment and control groups, where the main difference is having engaged in MOUD or not. Additionally, Table 2 contains the means for all variables used in the logistic regression model before and after matching. There are also *p* values from tests of significance where we compared the treatment and control groups. We also present a measure of bias which we computed using

[1] To perform our PSM, we used the "MatchIt" package in R and compared nearest neighbor, full, optimal, and coarsened exact matching using standardized mean differences produced by those techniques. Nearest neighbor provided the lowest standardized mean difference of these methods.

the following formula from Rosenbaum and Rubin (1985):

$$Bias = \frac{100(\bar{X}_t - \bar{X}_c)}{\sqrt{\frac{(S_t^2 + S_c^2)}{2}}}$$

The equation above produced a standardized mean difference between our treatment and control groups for each variable used in our PSM procedure. $\bar{X}_t$ and S_t^2 were the mean and variance of the MOUD participants and $\bar{X}_c$ and S_c^2 were the mean and variance for our untreated control group. We followed the suggestion of Rosenbaum and Rubin (1985) of a bias statistic equaling more than 20 as an indication that the treatment and control groups are unbalanced.

As Table 2 depicts, our PSM reduced the bias in all our measures. While many of the covariates we matched upon were not unbalanced nor were the treated and untreated groups significantly different from one another in our initial sample of 3,667, we also included measures that were related to criminal history and treatment need (e.g., positive diagnostic) to ensure our treatment and control groups were as similar as possible for our analyses. Where the treatment group was significantly different from untreated cases before matching, after matching, those differences are no longer present in our final sample of 714 (357 treated and 357 untreated). Overall, after matching, none of our bias estimates are above 20, suggesting a balance between treated and untreated cases.

Results

Table 3 displays the overall recidivism rates for our sample. Individuals who received MOUD had lower rates of recidivism at one year than their untreated counterparts. When comparing the means of these recidivism outcomes (not presented), new arrests and new felony convictions were significantly different between groups. More specifically, those in the comparison groups had higher rates of recidivism than those who received MOUD. Indeed,

across all four recidivism outcomes, those who received MOUD also had lower rates of recidivism. Conversely, those who received MOUD had a higher rate of mortality than those in the comparison group, but this was not a statistically significant difference.

Table 2. Propensity Score Matching and Covariate Balance for MOUD Treatment among Incarcerated People with OUD Diagnoses

Variables	Sample	MOUD Mean	Comparison Mean	Bias	t-test P value
Propensity Score	Unmatched	0.127	0.104	934.89	0.000
	Matched	0.126	0.126	0.00	0.999
Received SUD Tx	Unmatched	52.00%	41.00%	36.31	0.000
	Matched	52.00%	51.00%	3.26	0.823
MnSTARR Risk Level	Unmatched	3.13	3.07	4.79	0.340
	Matched	3.12	3.13	-0.82	0.879
Discipline	Unmatched	2.98	3.69	-1.08	0.133
	Matched	2.98	2.67	0.57	0.543
Any Visitation	Unmatched	22.56%	31.91%	-40.17	0.000
	Matched	22.69%	21.85%	3.93	0.788
Positive Diagnostic	Unmatched	92.00%	94.00%	-23.64	0.174
	Matched	92.00%	92.00%	0.00	0.892
Age at Release	Unmatched	32.60	33.255	-0.83	0.184
	Matched	32.63	31.85	1.14	0.165
Racial/Ethnic Minority	Unmatched	40.11%	48.67%	-28.64	0.002
	Matched	40.34%	40.34%	0.00	1.000
Length of Stay	Unmatched	10.90	14.103	-1.55	0.000
	Matched	10.92	10.912	0.01	0.988
Prior Prison Admissions	Unmatched	3.159	3.507	-3.20	0.043
	Matched	3.163	3.115	0.48	0.820
Total Convictions	Unmatched	17.120	17.16	-0.03	0.945
	Matched	17.129	16.77	0.27	0.641
Drug Offense	Unmatched	31.48%	29.09%	9.17	0.348
	Matched	31.65%	31.65%	0.00	1.000
DWI Offense	Unmatched	6.41%	4.22%	33.02	0.058
	Matched	6.16%	6.16%	0.00	1.000
Person Offense	Unmatched	25.35%	30.42%	-20.95	0.047
	Matched	25.49%	26.89%	-5.94	0.671
Property Offense	Unmatched	18.94%	16.12%	15.56	0.173
	Matched	18.77%	17.37%	7.62	0.627
Sex Offense	Unmatched	5.29%	5.39%	-1.62	0.941
	Matched	5.32%	5.32%	0.00	1.000
Other Offense	Unmatched	12.53%	14.73%	-15.54	0.265
	Matched	12.61%	12.61%	0.00	1.000

Total MOUD = 359; Total Comparison Group Pool = 3,007; Matched MOUD = 357; Matched Comparison =

357

Our multivariate analyses were two-fold, first we examined cause-specific cox regression models. Next, we estimated competing risks models, presented in Table 4. Within our models, we included the propensity score as opposed to the 16 variables used to match our comparison group to treated cases. We do this because our propensity score variable captured the variation present in those 16 matching covariates for all our participants (Clark, 2024; Duwe, 2014; Duwe & McNeeley, 2021). Overall, when comparing the cause specific and competing risks models, they were not substantively different. Therefore, we only present the latter.

Competing Risks

We modeled the sub-distribution hazards for our four types of recidivism and mortality given the competing risks associated with our outcomes. As seen in Table 4, MOUD has significant effects on reducing the risk of re-arrest and new felony convictions. Indeed, risk of a re-arrest decreased by 36.2% (SHR = 0.638; $p \leq .01$), whereas risk of a new felony conviction saw a decrease of 28.1% in the risk associated with experiencing that outcome (SHR = 0.719; $p \leq .01$). Where individual releasees were discharged from prison without supervision, risk of a new conviction increased by 72% (SHR = 1.720; $p \leq .05$), re-arrest risk increased by 82.8% (SHR = 1.828; $p \leq .05$), and the risk of a new offense reincarceration increased by 109.7% (SHR = 2.097; $p \leq .001$) relative to those who were released to standard supervision.

However, incarcerated persons who were released as part of the Challenge Incarceration Program (CIP) and work release program which involve more intensive supervision saw decreased risk of new felony convictions (SHR = 0.417; $p \leq .001$ & SHR = 0.649; $p \leq .05$, respectively). Moreover, people released through CIP also saw reduced risk of new offense reincarceration (SHR = 0.422; $p \leq .001$) while those who were part of the work release program saw reduced risk associated with re-arrest (SHR = 0.426; $p \leq .05$). Given the nature of intensive

supervision (SHR = 3.160; $p \leq .001$) and CIP (SHR = 3.003; $p \leq .001$), being on either form of supervision is associated with an increased risk of supervision revocation. Work release also reduced the risk of new offense reincarceration by 30.1% (SHR = 0.699; $p = 0.053$) but did not quite reach statistical significance.

Table 3. One-Year Recidivism and Mortality Rates for MOUD Participants and Comparison Group

Outcome	MOUD Participants	Matched Comparison
Re-Arrest	5.3%	7.0%
Supervision Revocation	10.4%	11.8%
New Offense Reincarceration	70.3%	81.5%
New Felony Conviction	53.8%	71.4%
All-Cause Mortality	1.7%	0.6%
N	357	357

Additionally, relative to women, men were at higher risk of experiencing re-arrest by 65.6% (SHR = 1.656; $p \leq .01$) whereas the number of mental health criteria one has was associated with an increased risk of release violation of 56.6% (SHR = 1.566; $p \leq .05$). Regarding mortality, body mass index was the sole significant covariate in the model which suggests that people with higher body mass indexes are at a 9.6% increased risk of mortality (SHR = 1.096; $p \leq .05$). During analysis, we pondered whether there was any difference in effect when MOUD was also paired with SUD treatment. To more fully explore this, we added an interaction effect in our modeling which indicated whether someone received both MOUD and SUD treatment (1) or received only one or neither (0). The results of these models are presented in Table 5. The estimates generated for the interaction term are similar for those who received MOUD alone, however, the magnitude of effect is greater in those who received both forms of treatment for two of the four recidivism outcomes. In fact, those who benefited from both treatments, saw a 41% reduction in risk for experiencing re-arrest (SHR = 0.590; $p \leq .01$) and a 21.7% reduced risk for a new offense reincarceration (SHR = 0.783; $p \leq .05$). However,

receiving a new felony conviction had a decrease in magnitude from 28.1% to 24.5% when MOUD and SUD treatment were both received (SHR = 0.755; $p \leq .05$). It is unclear why this is the case.

Table 4. Competing Risks Models Predicting Post-Release Recidivism and Mortality

Independent Variables	Re-Arrest SHR (SE)	Supervision Revocation SHR (SE)	New Offense Reincarceration SHR (SE)	New Felony Conviction SHR (SE)	All-Cause Mortality SHR (SE)
MOUD	0.638** (0.145)	0.795 (0.182)	0.868 (0.090)	0.719** (0.100)	0.693 (0.595)
Male	1.566* (0.196)	1.190 (0.255)	1.013 (0.123)	0.885 (0.129)	0.488 (0.678)
Married	0.959 (0.228)	1.015 (0.324)	0.985 (0.157)	0.928 (0.174)	1.128 (0.765)
Mental Health Criteria	0.943 (0.082)	1.126 (0.094)	0.875* (0.053)	0.902 (0.059)	1.014 (0.220)
Released to MSP Area	1.021 (0.132)	1.564* (0.188)	1.007 (0.089)	0.917 (0.099)	2.788 (0.584)
STG Affiliation	1.256 (0.169)	1.055 (0.235)	1.003 (0.114)	1.058 (0.126)	1.257 (0.499)
Post Release Employment (1 yr.)	0.972 (0.133)	0.781 (0.184)	0.953 (0.091)	0.931 (0.100)	0.499 (0.494)
Release Type (Ref – Standard Supervision):					
Unsupervised	1.828* (0.282)	0.492 (0.559)	2.097*** (0.206)	1.720* (0.218)	---
CIP	0.579 (0.284)	3.003*** (0.270)	0.442*** (0.170)	0.417*** (0.196)	3.273 (0.743)
Work Release	0.426* (0.367)	1.032 (0.438)	0.699 (0.185)	0.649* (0.205)	2.262 (0.714)
Intensive	1.036 (0.189)	3.160*** (0.221)	1.110 (0.118)	0.880 (0.135)	1.106 (0.564)
Body Mass Index	---	---	---	---	1.096* (0.041)
Propensity Score	3.004 (1.412)	0.207 (2.094)	0.791 (1.017)	1.046 (1.120)	0.042 (4.349)

SHR = sub-distribution hazard ratio; SE = Robust Standard Error; MSP = Minneapolis-St. Paul; STG = security threat group; CIP = Challenge Incarceration Program; n = 714; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$

Table 5. Competing Risks Models with Interaction Effect Predicting Post-Release Recidivism

Independent Variables	Re-Arrest SHR (SE)	Supervision Revocation SHR (SE)	New Offense Reincarceration SHR (SE)	New Felony Conviction SHR (SE)
MOUD*SUD Treatment	0.590** (0.184)	0.643 (0.240)	0.783* (0.112)	0.755* (0.127)
Male	1.626* (0.197)	1.176 (0.254)	1.021 (0.123)	0.935 (0.128)
Married	0.966 (0.229)	1.030 (0.324)	0.986 (0.155)	0.926 (0.173)
Mental Health Criteria	0.938 (0.080)	1.127 (0.095)	0.876* (0.053)	0.900 (0.059)
Released to MSP Area	1.011 (0.132)	1.560* (0.187)	1.021 (0.090)	0.911 (0.100)
STG Affiliation	1.261 (0.170)	1.048 (0.234)	1.014 (0.114)	1.069 (0.127)
Post Release Employment (1 yr.)	0.984 (0.133)	0.802 (0.184)	0.962 (0.092)	0.938 (0.100)
Release Type (Ref – Standard Supervision):				
Unsupervised	1.789* (0.277)	0.480 (0.564)	2.055*** (0.207)	1.650* (0.221)
CIP	0.627 (0.292)	3.345*** (0.274)	0.474*** (0.174)	0.440*** (0.202)
Work Release	0.430* (0.369)	1.012 (0.439)	0.696 (0.186)	0.662* (0.206)
Intensive	1.006 (0.190)	3.083*** (0.221)	1.091 (0.118)	0.856 (0.136)
Propensity Score	6.721 (1.448)	0.480 (2.169)	1.398 (1.044)	2.199 (1.142)

Notes: SHR = sub-distribution hazard ratio; SE = Robust Standard Error; MSP = Minneapolis-St. Paul; STG = security threat group; CIP = Challenge Incarceration Program; n = 714; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$

Interestingly, when pairing SUD treatment with medication-assisted treatment, there is a further reduction in risk of re-arrest and new offense reincarceration. The risk associated with these outcomes decreased by 4.8% for re-arrests and 8.5% for new offense reincarceration as compared to MOUD alone. Further, when MOUD is paired with SUD treatment, the effect on

new offense reincarcerations becomes statistically significant as opposed to MOUD alone which was not. While the effects of MOUD on supervision revocation did not reach statistical significance, when coupled with SUD treatment, the effects were approaching significance such that incarcerated persons who received both were at a 35.7% reduced risk (SHR = 0.643; p = 0.065). The results from our other covariates are more or less similar to the models detailed in Table 4.

Parameter estimates in models examining differential effects of the number of MOUD doses received and having received suboxone or vivitrol were not substantively different from having received either/both under the MOUD variable. Similarly, models estimating the effects of covariates on all-cause mortality and our four types of recidivism using competing risks modeling did not return results which were substantively different from the mortality model in Table 4. Therefore, we only present the latter model. To be thorough, mortality models were also produced using the full matching pool of 3,367 releasees, results contained within were no different from the estimates presented within Table 4. Lastly, as a supplementary analysis, we estimated both the average treatment effect (ATE) and average treatment effect on the treated (ATT) then re-ran our final analyses to ensure our results were robust. The addition of these weights in our supplemental analysis did not yield significantly different results from our PSM data. The coefficients and hazard ratios were slightly different but did not change the relationships between our independent and dependent variables.

Conclusion

This study provides an important addition to the literature on MOUD in carceral settings which has, thus far, primarily included studies which utilized no comparison groups nor samples that were large enough for more rigorous statistical analysis (Moore et al., 2019). Consistent with

some previous literature related to MOUD in carceral settings (Albizu-Garcia et al., 2007; Dolan et al., 2005; Dole et al., 1969; Evans et al., 2021; Lobmaier et al., 2010; Westerberg et al., 2016; Zaller et al., 2013), we found evidence that the MOUD program in Minnesota state prisons reduces recidivism. More specifically, MOUD reduces the risk of new prison admissions, new arrests, and new felony convictions within the state. However, we did not find evidence that MOUD is effective at reducing the risk of all-cause mortality or of release violation. We also found that pairing MOUD with SUD treatment further reduced recidivism risk across three of our four types of reoffending.

These findings suggest that prisons should expand the utilization of MOUD to include more incarcerated persons suffering from OUD while also pairing it with SUD treatment to see optimal outcomes in recidivism reduction. At present, MOUD is only available to those with a time to serve of 120 days or less. Because of this, it is unknown whether the provision of MOUD to people suffering from OUD who are incarcerated with lengthier sentences would benefit from this treatment. Therefore, future research should examine whether this mode of treatment is effective for persons serving longer sentences. While limited, previous research does suggest that longer treatment times, specifically regarding MOUD, are more beneficial (Cunningham et al., 2020).

Our study is not without limitations. First, it is unclear if there is any further reduction in recidivism when formerly incarcerated persons who received MOUD while in prison continue their treatment in the community post-release. Previous literature would suggest this is the case (Mitchell, 2022; Moore et al., 2019; Strange et al., 2022). However, at present, MnDOC does not collect data related to community continuation of treatment for formerly incarcerated persons. Associated with this are the relatively poor economic and employment outcomes experienced by

many formerly incarcerated persons (e.g., Travis et al., 2001; Visher et al., 2004; Western et al., 2001). Many individuals who are released from prison cannot afford to continue treatment in the community. Therefore, the state may wish to partner with local community MOUD providers for those who wish to continue treatment for low or no cost to the client.

Second, while we minimize the potential for selection bias using our PSM technique, we cannot correct for all potential bias within our sample, especially given that we cannot fully account for motivation and its effects on seeking and/or engaging in treatment. Given that participation in MOUD is largely self-selected, this proved difficult to account for in empirical studies using retrospective designs. Third, we were unable to include measurements related to how treatment was ended (i.e., voluntary or involuntary termination) as this information is not currently tracked. Finally, we were unable to assess the effect of length of treatment with medication and completion of treatment. In its present state, there is no metric for "completion" of treatment. This is understandable as recovering from substance dependency is a continuing effort, it does, however, make it difficult to control for those who "complete" treatment and those who do not.

Overall, this study has demonstrated that MOUD can be an effective way to combat the effects of OUD on recidivism. While we did not find evidence suggesting this form of treatment improves mortality risk, there are other studies which have (Lee et al., 2015; Marsden et al., 2017). Therefore, there should be wider implementation of MOUD in jails and prisons across the United States.

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