Journal of Experimental Criminology
https://doi.org/10.1007/s11292-024-09653-6

Long-term effects of medication-assisted treatment in opioid using offenders in German prisoners—treatment outcomes in prison and after release

Mark Stemmler[1] · Kerstin Geißelsöder[1] · Maren Weiss[2] · Mavi Hornegger[1] · Johann Endres[3]

Accepted: 16 November 2024
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Abstract

Objectives The aim of this study was to examine the long-term effects of medication-assisted treatment after release from prison. We compared prisoners receiving medications for opioid use disorder (MOUD) to prisoners receiving no MOUD, on a number of outcome variables. Self-reported drug use was confirmed with laboratory tests.

Methods A sample of 247 prisoners in German prisons completed the European Addiction Severity Index shortly before release. Subjects were contacted again at 1, 3–6, and 12 months after release for telephone interviews.

Results Compared to no-MOUD subjects, MOUD subjects reported fewer illegal opioids and significantly fewer non-prescribed substitution medications. MOUD participants showed high treatment continuity through 12 months. Benefits of MOUD peaked at 3–6 months; effects were reduced at 12 months. Convergent validity of the self-report measure of drug use with laboratory drug screenings was satisfactorily high (~ 71% convergence).

Conclusions For long-term sustainability of MOUD effects, additional psychosocial interventions are recommended.

Keywords Drug screening tests · Employment · Legal probation · Medication-assisted treatment · Persons with opioid use disorder · Medications for opioid use disorder (MOUD) · Prison · Validity of self-reports of drug use

✉ Mark Stemmler
mark.stemmler@fau.de

[1] Department of Psychology, Friedrich-Alexander-University (FAU) Erlangen-Nuremberg, Naegelsbachstr. 49c, 91052 Erlangen, Germany

[2] SRH University of Applied Sciences Heidelberg Campus Fürth, Fürth, Germany

[3] Bavarian Prison Service Criminological Research Unit, Erlangen, Germany

Published online: 10 December 2024

Introduction

A significant proportion of incarcerated people in Germany and Europe are opioid misusers (European Monitoring Centre for Drugs & Drug Addiction, 2022; Länderarbeitsgruppe "Bundeseinheitliche Erhebung zur stoffgebundenen Suchtproblematik im Justizvollzug", 2022). However, empirical findings on the treatment of opioid use disorder among incarcerated people have been inconsistent, with existing studies coming primarily from the USA and English-speaking countries. Few empirical studies have been conducted in Europe and especially Germany. The findings presented in this paper were derived from the research project "Imprisonment for persons with opioid use disorder—an evaluation study" (HOPE study) funded by the Bavarian State Ministry of Justice. The HOPE study aimed at clarifying whether medication-assisted treatment, especially medications for opioid use disorder (MOUD) or primarily abstinence-oriented treatment (no MOUD), leads to more favourable long-term outcomes with regard to drug use, treatment of opioid misuse, legal probation, employment, and health status after release from prison.

With regard to the use and availability of illegal substances, prisons are a ''high-risk environment" (Schalast, 2023, p. 565). In German prisons in 2022, 24% of inmates had a substance use disorder and 15% misused substances (Länderarbeitsgruppe "Bundeseinheitliche Erhebung zur stoffgebundenen Suchtproblematik im Justizvollzug", 2022). Of all incarcerated people with substance misuse problems, about 16% reported opioids as their main substance, which corresponds to 6% of the prison population. In addition, many individuals use multiple substances, including opioids. In total, approximately 8–21% of incarcerated people use opioids in Germany. This means that opioid misuse and opioid use disorder are significantly overrepresented in prison compared to the general population and, therefore, pose particular challenges for prisons in management and treatment.

According to the German correctional (prison) laws, a prison sentence should only restrict the freedom of the convicted person but not on other areas of life. The "equivalence principle" states that prisoners are entitled to medical treatment comparable to what they would receive as a legally insured free citizen. In addition, according to the guidelines of the German Medical Association for the medication-based treatment of persons with opioid use disorder, "the continuity of treatment should be ensured by the admitting institution in the event of a transition from outpatient medication-assisted treatment to hospital treatment, rehabilitation measures, imprisonment or other forms of inpatient accommodation and vice versa" (German Medical Association, 2023, p. 8). The European Court of Human Rights ruled that a categorical refusal of medication treatment without a medical examination of the individual case violates the prohibition of inhumane treatment (Art. 3 European Convention of Human Rights; judgment of 01.09.2016, Ref. 62,303/13). Following this ruling, there was an increase in substitution rates among the prison population in Germany: in 2018, 1440 prisoners with opioid use disorder received medication-assisted treatment, which corresponds to a substitution rate of 24%. The substitution rate was calculated by relating the number of MOUD to the number of misusers with opioids as their main substance. (Länderübergreifende Arbeitsgruppe

"Stoffgebundene Suchtproblematik", 2019). In 2022, a total of 2906 prisoners were undergoing medication-assisted treatment, which corresponds to a substitution rate of 46% (Länderarbeitsgruppe "Bundeseinheitliche Erhebung zur stoffgebundenen Suchtproblematik im Justizvollzug", 2022). In their meta-analysis, Glanville et al. (2022) considered 22 randomized controlled trials (RCTs) with regard to the efficacy of pharmacological interventions (e.g. methadone, buprenorphine, naltrexone, and cyclazocine, which is a synthetical chemical compound and a mixed opioid agonist/antagonist) relative to psychological interventions (like counselling). Of the 22 studies, 14 were conducted in the USA and three in the UK. Additional studies were conducted in Iran, Australia, Norway, Sweden, and Mexico. All but one study included adult male participants who used drugs. The meta-analysis revealed a small statistically significant mean difference favouring pharmacological interventions over psychological interventions in reducing drug use and criminal activity. When comparing different pharmacological treatments with one another, there were no significant differences between those applied in the investigated studies.

In our own meta-analysis (Boksán et al., 2023), we included studies with quasi-experimental designs in addition to RCTs. Our literature search yielded $N = 15$ studies of incarcerated people receiving MOUD that included data on drug use after prison release. Of these 15 studies, only three were conducted outside the United States (one in Australia, Dolan et al., 2003; one in Canada, Johnson et al., 2001; one in Norway, Lobmaier et al., 2010). The results showed a positive effect of MOUD on treatment engagement after discharge (i.e. continuation of MOUD after release). In addition, positive effects of MOUD were found on opioid use, overall illicit drug use, and re-incarceration rates. However, some sample sizes were small, and the follow-up time intervals were mostly short. The vast majority of studies came from the USA; because of the differences in the justice systems by country, the results cannot be generalized easily.

Studies on drug use that rely mainly on self-report are strengthened by including drug screenings. Drug screenings are an important part of substance misuse and medication-assisted treatment and are very frequently used in prisons and probation services (Egbert et al., 2018) to detect legally and illegally consumed substances in a person's bodily fluid (Schmid, 2003). The test should be carried out spontaneously and promptly after suspected substance misuse, as the analytes are sometimes broken down quickly. It is also important to record patient information on medication intake (Wilhelm, 2008). Certain decision limits (i.e. cut-offs) are used when analyzing the sample material. Above the cut-off, the test is positive; below, it is negative (Schmid, 2003; Wilhelm, 2008). In order to avoid false-positive and false-negative results, sensitivity and specificity must be high (Egbert et al., 2018). In the HOPE study, we applied drug screenings in order to assess the reliability and validity of the self-reported illegal drug usage.

Study scope

This study is an expansion of our previous work (Geißelsöder et al., 2024), in which we compared incarcerated people with opioid use disorder who were treated with

MOUD (i.e. treatment group) to those who did not receive MOUD (i.e. no MOUD is the control group) in the German federal state of Bavaria on opioid misuse-related outcomes just before release and at 1 month and 3 to 6 months after release. This study found that while in prison, subjects in the treatment group used less illicit opioids and non-prescribed substitution medication compared to no MOUD. After release, the advantages of MOUD persisted, such that the treatment group used less illicit opioids and non-prescribed substitution medication. In addition, they reported less craving for opioids and displayed a high treatment continuity. The goal of the present study was to look at long-term effects of MOUD up to 1 year after prison release, with regard to drug-related outcomes. Furthermore, we examined outcomes such as hospitalization, legal probation, and employment. In addition, we investigated the validity of self-reported drug use. Our research questions were as follows:

1. Does the intake of medications for opioid use disorders (MOUD) while incarcerated reduce illicit opioid use, overall illicit drug use, opioid craving, opioid withdrawal symptoms and non-fatal drug overdoses up to 1 year after release from prison?
2. How sustainable are our previously reported favourable outcomes of MOUD compared to no MOUD (also with regard to post-release treatment continuity)? Will they persist until 12 months after release?
3. Will similar positive effects be observed in non-drug related outcome variables, such as legal probation, employment, and health status (e.g. less hospitalization)?
4. Do subjects in a criminological research study report their drug usage accurately?

Methods

This study was a multicentre observational study conducted in Bavarian state prisons and funded by the Bavarian Ministry of Justice. The goal was to examine the effects of MOUD (treatment group) versus no MOUD (control group) for incarcerated persons with an opioid use disorder on their behaviour in prison, as well as health status, substance misuse or relapse, legal probation, and employment after release.

In Germany, a diagnosis of opioid use disorder is based on the ICD 10 criteria (World Health Organization, 1992). In this study, the medical staff of the prison hospital departments were responsible for diagnosis and, therefore, also for the final assignment to the study groups. The assignment to the MOUD (treatment) group or to the no MOUD (control) group was based on the decision of the medical staff at admission to the prison and the participant's treatment preferences. Treatment decisions were made independently of participation in the study (the research team consisting of psychologists had no influence on the treatment). Randomization to experimental groups was not possible. Participants who did not receive MOUD had the same access to medical treatment and social services as the MOUD group, but they did not receive any opioid substitutes such as methadone or buprenorphine;

however, they received other medications if requested such as benzodiazepines, pain killers, or barbiturates.

Study design

To be eligible to participate in the study, all participants had to be at least 18 years old, had to have spent at least 3 months in the Bavarian correctional system, and had to be due to be released within four weeks. Participants were not excluded for multiple drug use if an opioid use disorder was diagnosed. In addition, participants had to speak and understand the German language (no interpreters were involved). In total, subjects were interviewed at four measurement times. The baseline assessment (T_0) took place while subjects were still in custody. The first follow-up measurement (T_1) took place approximately 1 month after release (time interval: $M = 5.57$ weeks, $SD = 2.63$). T_2 occurred three to 6 months after release (time interval: $M = 16.83$ weeks, $SD = 6.54$), and the last follow-up assessment T_3 was conducted 12 months after release (time interval: $M = 54.73$ weeks, $SD = 13.29$). In this paper, we present only data from T_0, T_2, and T_3; because we are particularly interested in long-term effectiveness of MOUD, the results of the 1-month follow-up will not be presented here (the reader may consult Geißelsöder et al., 2024). Participation was voluntary and not related to any advantages during their prison term. In order to support the involvement in the study, incentives were a packet of coffee (in prison) or supermarket vouchers after release (T_1, 50 € voucher value; T_2 and T_3, 100 € voucher value each).

Study recruitment took place in cooperation with the prison administration. Assigned contact persons informed eligible prisoners about the study and arranged an interview appointment. An active written informed consent was obtained from each participant before the first interview was conducted. Subjects were assured that their responses would be kept confidential and not shared with correctional staff or administration. During the first interview, all subjects were asked to provide reliable contact information to be used after release. Baseline assessments (T_0) were conducted either in person in prison or, after the start of the COVID-19 pandemic, by telephone. All interviews were conducted in rooms without acoustic monitoring. All follow-up interviews were conducted by telephone. The study was approved by the Ethics Committee of Friedrich-Alexander-University Erlangen-Nuremberg (FAU; 15.11.2019, application no. 382_19 B).

Measures

European Addiction Severity Index

The European Addiction Severity Index (EuropASI; Gsellhofer et al., 1997; McLellan et al., 1992), a validated standardized interview procedure, was used. For the first interview (T_0), we adapted a version to the prison conditions. Subsequently, a shortened but otherwise largely unchanged version of the EuropASI was adapted for the post-release follow-up interviews (T_2, T_3). The semi-structured interview

assessed seven independent problem areas: general information, physical condition, work situation, alcohol and drug use, legal situation, family and social relationships, and mental health.

The *alcohol and drug use* section of the EuropASI examines age at first drug use and current use of various substances ("What drugs/substances have you used ever /since the last interview?"). Questions about opioid craving, opioid withdrawal symptoms (physical complaints, e.g. nausea, sweating), overdoses, MOUD, employment, and hospitalization were also part of the EuroASI. The interview in custody (T_0) recorded drug use, craving, opioid withdrawal symptoms, and workplace during incarceration. The data from follow-up points T_2 and T_3 measured outcomes (i.e. drug use, craving, opioid withdrawal symptoms, overdoses, hospitalization, employment, and crimes committed) since the previous interview and MOUD status at the time of the interview. Data on disciplinary punishments while in custody (e.g. for drug possession or illicit trading) was obtained from prison files.

Saliva sampling and analysis

The most commonly used test for the detection of drugs is liquid chromatography-tandem mass spectrometry (LC–MS; Grebe & Singh, 2011). It offers better analytical specificity and sensitivity than immunoassays and other laboratory methods (Drummer, 2006; Schmid, 2003). Saliva samples were analyzed by the Staber laboratory using the LC–MS technique for the various substances. The cost of a laboratory analysis was €52. Results (positive/negative) were reported for illegal opioids, prescribed MOUD drugs, cannabinoids, amphetamines, cocaine, benzodiazepines, pregabalin, and other substances. The GREINER SCS® system was used to collect saliva samples. The subject rinsed an extraction solution in their mouth for 2 min. The time was measured by the project staff using a stopwatch or a cell phone. Then, the project staff placed the sample material, sucked up through a Vacutainer tube, into a transparent laboratory bag while wearing gloves and sent it to the laboratory. The waste was disposed of in a garbage bag.

Sample

Participant recruitment took place between February 2020 and May 2022. Almost all Bavarian correctional facilities with appropriate subjects participated in the study (i.e. 20 prisons). At the baseline interview (T_0), the total sample included $N = 247$ subjects. The treatment group consisted of $n_{MOUD} = 139$ (56%) and the control group of $n_{no\ MOUD} = 108$ (44%) subjects. For more information regarding the sample, see Table 1.

Levomethadone (27% of MOUD patients) was the most frequently used MOUD medication, followed by methadone (16%), buprenorphine depot (10%), and buprenorphine (7%). Rarely used were morphine (2%) or a combination of buprenorphine and naloxone (1%).

After release, the sample size dropped from $N = 247$ to $n = 133$ (T_1; retention rate 54%), $n = 150$ (T_2; retention rate 61%), and $n = 144$ (T_3; retention rate 59%). We obtained at least one follow-up assessment information from 72% of

Table 1 Demographics and health issues at baseline

Sample characteristics	MOUD in prison ($n=139$)	No MOUD in prison ($n=108$)	Complete sample ($N=247$)
Age (years; *M* (*SD*))	38.54 (8.23)	36.09 (8.67)	37.47 (8.50)
Male *n* (%)[†]	117 (84%)	99 (92%)	216 (87%)
German nationality *n* (%)	127 (91%)	81 (76%)	208 (85%)
Completed vocational training *n* (%)	72 (52%)	45 (42%)	117 (48%)
Hepatitis infection (ever) *n* (%)	112 (81%)	58 (54%)	170 (69%)
Ever injected drugs *n* (%)	134 (96%)	79 (74%)	213 (87%)
Years of injecting drug use (*M* (*SD*))	12.38 (8.10)	11.00 (7.65)	11.83 (7.94)
Length of current prison sentence (months, *M* (*SD*))	16.35 (19.40)	20.14 (20.00)	17.99 (19.71)
MOUD lifetime *n* (%)	124 (90%)	51 (47%)	175 (71%)

Percentages refer to the respective group (MOUD / no MOUD / full sample). A similar version of this table was presented in Geißelsöder et al. (2024); this table is necessary to illustrate the demographic variables and health related issues of the sample at baseline (in custody)

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[†] $n=0$ participants identified themselves as other/non-binary

the baseline sample across time. During the study period, there were 3 deaths among the study participants. One person died in the period 3–6 months after release from prison, and two in the period 6–12 months after release. The drop-out rate was not significantly different by group ($X^2_{(1)}=1.20$, $p=0.274$). The dropout rate was 25% in the MOUD group ($n=35$) and 32% in the non-MOUD group ($n=34$); this was comparable to other longitudinal studies with a sample of incarcerated people who use drugs (retention rates of 43–69% (e.g., Clark et al., 2020; Crisanti et al., 2014; Stewart et al., 2021). The retained sample revealed some potentially worse outcomes for the attendees in comparison to the drop-outs such that they had significantly more heroin injecting use (an indicator for severe dependency) and also more previous substitution experience (this comparison was, however, non-significant). Unfortunately, many participants provided contact information that was incomplete or insufficiently detailed (e.g. invalid mobile phone number, email address, or postal address) and therefore dropped out of the study. Active refusal to participate further in the study was rare ($n=5$).

A total of $n=33$ saliva tests were carried out under the supervision of the research team and then analyzed in the Staber laboratory in Munich. Drug tests for the remaining participants were obtained by the staff, with the consent of the subject, from medical records from the MOUD doctors, treatment facilities, or prisons. Of these, $n=3$ were saliva tests, $n=28$ were urine tests, $n=2$ were blood tests, and $n=1$ was a hair sample. No drug test information was available for $n=19$.

Intent to treat versus as treated

After release from prison, not all subjects continued with their MOUD, while others only began the MOUD after release. To account for the switches between the two groups, both intent-to-treat (ITT) and as-treated (AT) analyses were conducted (Shrier et al., 2014). The AT subjects were investigated as part of the group to which they belonged at the time of the respective follow-up assessment. For example, a subject who had not received MOUD in custody but started MOUD after release before follow-up time point T_1 was considered part of the MOUD group at follow-up point T_1. In addition, ITT analyses were carried out, taking into account the distribution of subjects in prison (T_0) at the baseline measurement, regardless of whether MOUD was discontinued or restarted after release. ITT corresponds more to actually applied situation, even though an underestimation of treatment effects in ITT is possible (Endres et al., 2016).

Inverse probability of treatment weighting (IPTW)

For legal and ethical reasons, randomization to treatment and control group was not possible. To ensure the comparability of the two groups, inverse probability of treatment weighting (IPTW) was applied (c.f. Austin, 2011; Chesnaye et al., 2022). At the first step, differences between the two groups were ascertained. There were differences in gender ($X^2_{(1)} = 3.11$, $p = 0.078$), age ($t_{(245)} = -2.26$, $p = 0.024$), and intravenous drug use ($X^2_{(1)} = 26.52$, $p < 0.001$; see Table 1). No group differences were found for other variables (e.g. nationality, completed vocational training, chronic diseases other than hepatitis, number of previous prison sentences). In preparation for the IPTW analysis, the variables gender, age, and intravenous drug use were entered into a logistic regression model as predictors, to calculate the respective propensity scores, which referred to the probability that a study subject would be included in the treatment group. Participants who received MOUD but had a low probability of being included in the treatment group were given a higher weight than participants who received MOUD but had a high probability of being included in the treatment group (therefore 'inverse" weighting in order to make the treatment group more similar to the control group). To prevent extreme weighting values from inflating the confidence intervals and the variance of the effect estimate, weight stabilization was performed (Chesnaye et al., 2022). Throughout the manuscript, both unweighted and weighted outcomes are reported for the intent-to-treat analyses.

Data were analyzed using SPSS 29. Due to the nominal scaling of the data, group comparisons were calculated using X^2 tests or the Fisher-Yates test. For the dichotomous dependent variables (e.g., opioid use), the odds ratio (OR) was chosen as the effect size measure. An $OR > 1.00$ represented an advantage for the treatment group (MOUD group); $OR < 1.00$ represented an advantage for the control group (no MOUD group). To avoid cells with frequencies of zero, 0.5 was added to the frequencies in both the treatment and control groups.

Results

As shown in Table 1, the sample recruited before release consisted of $N = 247$ subjects (216 males; 31 females); the mean age was 37.47 years ($SD = 8.50$). The vast majority (87%) were German citizens. Only half of the sample (48%) had completed vocational training. Four subjects in the MOUD group were HIV positive; none in the control group. More than two-thirds of the sample ever suffered from hepatitis (MOUD, 81%; no MOUD, 54%). Intravenous drug injection was present in almost all subjects in the treatment group and in 74% of the control group. The average length of current imprisonment was 1.5 years; the subjects had on average about four imprisonments (MOUD: $M = 4.76$, $SD = 4.79$; no MOUD: $M = 3.64$, $SD = 3.71$). Ninety percent of the treatment group and 47% of the control group ever used MOUD.

Almost half of the sample (48%) used at least one illicit substance in prison (see Table 2). Cannabis was the most frequently used illicit substance (19% of the sample reported use at least once), followed by synthetic cannabinoids (16%), opioids (except heroin, methadone, or buprenorphine; mostly fentanyl; 16%), heroin and buprenorphine (14% each), benzodiazepines (13%), and cocaine (6%).

As shown in Table 2, subjects in the MOUD group used less opioids ($OR = 2.22$), consumed less non-prescribed (illegally used) substitution medication ($OR = 4.51$), and reported less opioid craving ($OR = 1.91$) while in prison (for more detailed information, see Geißelsöder et al., 2024). The treatment group, however, reported more disciplinary punishments related to the opioid use disorder than the control group ($OR = 0.53$; this comparison was significant). For the other variables like other drug use, symptoms of withdrawal, any disciplinary punishments ever, and a workplace in detention, no significant group differences were found.

The effects of MOUD after the release from prison after 3 to 6 months (T_2) and after 1 year (T_3) are shown in Table 3. Our ITT analyses revealed that at T_2, the MOUD group reported significantly less illicit use of opioids ($OR = 3.05$), less opioid cravings ($OR = 3.14$), and less non-fatal overdoses ($OR = 5.51$) than the no MOUD group; the non-prescribed (illegally used) substitution medication ($OR = 4.72$), however, did not reach the level of significance. Eighty-nine percent of the treatment group continued their MOUD treatment (see also Geißelsöder et al., 2024). After 1 year, the MOUD showed still some advantages over the no MOUD group, but no significant group differences could be detected anymore. Fewer subjects were employed in the MOUD group than in the control group (23% versus 34%). At T_3, 79% of the MOUD group had continued their MOUD treatment, while 32% of the control group started an MOUD treatment. While taking the treatment switching into account, we had a closer look at those with complete data for at least three measurement points. Of those subjects ($N = 143$), $n = 66$ (46%) stayed continuously in the treatment group (MOUD) at all time points up to T_3 and $n = 40$ subjects (28%) remained stably in the control group (no MOUD) at all time points after 1 year. A comparison between those "pure" groups did not reveal more significant differences in terms of the

Table 2 Drug use and drug-related issues while in prison

Interview data initial survey	Unweighted analysis				Weighted analysis	
	MOUD in prison ($n=139$)	No MOUD in prison ($n=108$)	p	OR	p	OR
Use of opioid	20%	36%	.006	2.22**	.002	2.48**
Use of other illicit drug	42%	41%	.787	0.79	.417	0.81
Illegal use of substitution medication without prescription	7%	24%	< .001	4.51***	< .001	5.38***
Use of at least one illicit substance	47%	49%	.718	1.10	.952	1.02
Opioid craving	22%	35%	.026	1.91*	.117	1.57
Symptoms of withdrawal	54%	50%	.689	0.86	.522	0.78
Disciplinary punishments ever	56%	51%	.471	0.82	.324	0.76
Disciplinary punishments related to substitution medication	27%	17%	.047	0.53*	.054	0.54+
Work place in detention	60%	61%	.960	0.99	.556	1.17

+$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$

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Table 3 Intent-to-treat analyses (ITT) testing the differences between the MOUD and no MOUD group after their prison release at the 3–6 months (T_2) and 12 months (T_3) follow-up

Time of measurement and variables	Unweighted analysis				Weighted analysis	
	MOUD in prison	No MOUD in prison	*p*	Odds ratio	*p*	Odds ratio
T_2 (3–6 months after prison release)	(*n* = 88)	(*n* = 62)				
Illicit opioid use	32%	59%	.002	3.05**	.002	3.07**
Other illicit drug use	62%	68%	.478	1.31	.401	1.38
Illegal use of substitution medication without prescription	3%	11%	.064	4.72+	.042	4.96*
Opioid craving	19%	42%	.004	3.14*	.003	3.38*
Withdrawal symptoms	41%	46%	.574	1.23	.605	1.21
Non-fatal overdose	3%	13%	.033	5.51*	.077	4.86+
MOUD treatment	89%	21%	.001	29.74***	.001	29.42***
Hospitalization	9%	9%	1.00	1.02	1.00	0.84
Committed crimes	37%	54%	.053	2.03+	.038	2.15*
Employment	12%	22%	.117	0.47	.326	0.61
T_3 (12 months after prison release)	(*n* = 85)	(*n* = 61)				
Illicit opioid use	46%	54%	.379	1.38	.111	1.78
Other illicit drug use	73%	67%	.502	0.76	.384	0.71
Illegal use of substitution medication without prescription	6%	9%	.482	1.66	.197	2.41
Opioid craving	22%	28%	.453	1.37	.768	0.88
Withdrawal symptoms	51%	45%	.539	0.80	.283	0.68
Non-fatal overdose	6%	7%	1.00	1.15	1.00	1.01
MOUD treatment	79%	32%	.001	7.81***	.001	6.64***
Hospitalization	27%	22%	.487	0.74	.541	0.77
Committed crimes	46%	48%	.814	1.09	.643	0.84
Employment	23%	34%	.177	0.58	.224	0.61

All statements regarding imprisonment refer to the prison sentence during which the first interview took place. The data for times 2 and 3 refer to substance use, the experience of craving, withdrawal symptoms, overdoses, hospitalizations, committed crimes, and employment since the previous interview and to the current substitution status at the time of the interview. Weighted analysis: Inverse probability of treatment weighting; odds ratio: effect size; OR > 1 indicates a benefit for the treatment group. $^{+}<.10$, $^{*}<.05$, $^{**}<01$, $^{***}p<.001$. The results of the T_2 follow-up were (partially) presented in Geißelsöder et al. (2024); these results were included in this table to illustrate the development of the drug-related outcome variables from over time from T_2 to T_3. Results for hospitalization, committed crimes and employment were not presented in Geißelsöder et al. (2024)

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Table 4 As-treated (AT) analyses testing the differences between the medications for opioid use disorder (MOUD) and no MOUD group after their prison release at the 3–6 months (T_2) and 12 months (T_3) follow-up

Time of measurement and variables	MOUD	no MOUD	*p*	Odds ratio
T2 (3–6 months after prison release)	(*n* = 85)	(*n* = 53)		
Illicit opioid use	34%	56%	.015	2.45*
Other illicit drug use	65%	64%	.949	0.98
Illegal use of substitution medication without prescription	1%	14%	.006	12.70**
Opioid craving	22%	39%	.043	2.24*
Withdrawal symptoms	42%	45%	.758	1.12
Non-fatal overdose	5%	10%	.304	2.11
Hospitalisation	10%	6%	.534	0.60
Committed crimes	42%	46%	.698	1.15
Employment	12%	22%	.143	0.50
T3 (12 months after prison release)	(*n* = 76)	(*n* = 52)		
Illicit opioid use	49%	50%	.942	1.03
Other illicit drug use	72%	69%	.754	0.88
Illegal use of substitution medication without prescription	3%	13%	.061	4.86+
Opioid craving	23%	26%	.715	1.17
Withdrawal symptoms	47%	50%	.772	1.11
Non-fatal overdose	6%	7%	1.00	1.15
Hospitalisation	23%	28%	.499	1.33
Committed crimes	44%	50%	.537	1.27
Employment	21%	37%	.060	0.47

The data for follow-up points 2 and 3 refer to substance use, the experience of craving, withdrawal symptoms, overdoses, hospitalisations, committed crimes and employment since the previous interview and to the current substitution status at the time of the interview. All analyses in this table were based on unweighted data. The results of the T_2 follow-up were (partially) presented in Geißelsöder et al. (2024); these results were included in this table to illustrate the development of the drug-related outcome variables over time from T_2 to T_3. Results for hospitalization, committed crimes, and employment were not presented in Geißelsöder et al. (2024)

MOUD medications for opioid use disorder

drug-related outcomes; however, in the pure no MOUD group, more subjects were employed (employment: MOUD = 24% versus no MOUD = 48%; $OR = 0.34$, $p < 0.05$). No significant differences were found for hospitalization, self-reported committed crimes, or employment. All effects were also present in the weighted analyses. Withdrawal symptoms were common and sometimes higher in the treatment group than the control group.

Similar to the ITT analyses, at T_2, the AT analyses (see Table 4) showed that the MOUD group had significantly less illicit use of opioids ($OR = 2.45$), illicit use of MOUD ($OR = 12.70$), and cravings ($OR = 2.24$). The significant difference in non-fatal overdoses for the ITT analyses, however, was not significant in the AT analysis (for more detailed information see Geißelsöder et al., 2024). After 1 year (T_3), the comparisons based on the AT analyses lost significance for the illicit opioid use and

craving but revealed a significant trend for the consume of non-prescribed (illegal use) of substitution medication ($OR = 4.86$). In short, ITT and AT analyses generated comparable results.

Drug screenings

For 86 subjects, drug screening data at 12 months after prison release was available (Hornegger, 2024). Of the 86, 34 were not using MOUD at the time of the screening, 51 test persons were using MOUD, and one person did not provide this information. We looked at opioid use, heroin use, and other illicit substances. We asked the subjects whether they have used any of the above-mentioned substances since the last data collection. A response of "yes" was considered a drug relapse. The "yes" self-report answers were compared to the positive laboratory test results (i.e. the detection of the consumed illegal substance). The self-reported drug using relapse rate in this subsample was 76% (use of any illegal substance) and was slightly higher in the no MOUD group (79%) than in the MOUD group (75%). With the help of the drug screening test, an overall relapse rate for any illegal substance was 64%; it was 46% for heroin-only use (no MOUD group, 47%; MOUD group, 45%).

In 77% of participants in the non-MOUD group, the laboratory drug screening (of any illegal drug) was available; 55% of participants in the MOUD group had a screening available (this was a significant difference: $z = -3.46$, $p < 0.001$). After controlling for the time gap between the actual laboratory test and the time of the interview (maximum of 14 days), agreement between self-report drug use and laboratory confirmed drug use was 78% for heroin, 71% for opioids, and 63% for other substances (Hornegger, 2024).

A number of participants reported more consumption in the interviews than could actually be detected with the drug screenings (i.e. overreporting). Twenty-four percent of participants did overreport and indicated illegal use of opioids in the self-report, but no opioid use was detected in the screening. On the other hand, no opioid use was reported in the interview, but screening was positive for only 5% of the test subjects (i.e. underreporting). In summary, the MOUD group tended to overreport (32% versus 12% in the no MOUD group), whereas the no MOUD group tended to underreport (21% versus 6% in the MOUD group).

Discussion

In this evaluation study, we examined the efficacy of MOUD versus no MOUD. In prison (T_0), subjects who received MOUD reported using less illicit opioids and less non-prescribed (illegal) use of MOUD than those who did not receive MOUD. After release, at the 3 to 6 months and the 1-year follow-up (T_2 and T_3), the intent-to-treat (ITT) analysis showed group differences in illicit opioid use, non-prescribed illicit MOUD use, opioid craving, and treatment continuity, favouring the MOUD group. In the as-treated analyses (AT), lower illicit opioid use, less illicit MOUD use, and less opioid craving were also observed in the MOUD group. These findings are

consistent with existing research in the prison setting (Hedrich et al., 2012; Sharma et al., 2016) and after release (Boksán et al., 2023; Glanville et al., 2022).

The study also sheds light on the illicit use of MOUD among incarcerated people. In the present study, subjects receiving MOUD reported less illicit drug use while in prison and at T_2 and T_3. This is consistent with studies in the general population (Gossop et al., 2003; Roche et al., 2008; Schulte et al., 2016). A quarter of the no MOUD group consumed non-prescribed (illegally used) subtitution medication in prison. This means that there is active trading and passing on of subitution medication in prisons (Gross, 2021; Havnes et al., 2013). While interviewing prison medical staff about the pros and cons of MOUD in prison, a substantial number indicated concerns that MOUD was being passed on to other people (Weiss et al., 2022). This is reflected in our results, where the MOUD group faced more disciplinary punishment related to the subtitution medication.

The MOUD group reported less opioid craving than those in the no MOUD group in prison and at the second follow-up, which is consistent with the findings by Johnson et al. (2001) and Sindicich et al. (2016). The treatment and control groups reported the same amount of withdrawal symptoms, which suggests that MOUD also produces withdrawal symptoms (European Monitoring Centre for Drugs & Drug Addiction, 2022).

We found fewer non-fatal overdoses in the MOUD group at T_2. The odds ratios indicate an advantage for the MOUD group at T_2 (OR = 2.11), but not at T_3 (OR = 1.15). Similarly, in their systematic review, Crowley and van Hout (2017) concluded that there was insufficient evidence of a reduction in non-fatal overdoses. It is possible that the amount of non-fatal overdoses depends on which MOUD drug is prescribed. In the study by Betts et al. (2016), most non-fatal overdoses occurred in the no MOUD group among frequent methadone users. Bretteville-Jensen et al. (2015) suggest that factors such as age, education, homelessness, or the use of other substances also appear to be relevant.

The post-release treatment continuity for the MOUD group was consistent with previous studies (cf. Boksán et al., 2023; Moore et al., 2019; Sharma et al., 2016).

Treatment maintenance in the MOUD treatment group can be considered high; almost 80% of participants were using MOUD. Interestingly, about one-third of the no MOUD group started MOUD after prison release. This highlights the popularity of MOUD. Therefore, the two study groups were more alike after 1 year (T_3) than at baseline, resulting in a reduction of the former significant differences. In our further research, we will compare those who remained stably in their assigned MOUD groups with those who switched their MOUD status back and forth.

Contrary to our expectations, we did not detect any significant or large differences between the two groups in terms of criminal activity. After 1 year, employment for both groups was low and even lower for the MOUD group. We are currently collecting data for a 2-year follow-up to see if there has been any change. The lower working rate of the MOUD group may be related to the negative side effects of opioid agonists like dullness, dizzyness, and tiredness. Daily visits to the doctor for MOUD can also make employment more difficult. Criminal activity at the 1-year follow-up was still high; almost half of the subjects in each group reported committing crimes. In the 2-year follow-up data collection, we will obtain subjects' official

crime records to test the true differences in criminal actvities between the two groups. One reason for continued criminal activity can be that criminal behaviours are part of one's lifestyle or routine (habituated), according to Situational Action Theory (SAT; Wikström et al., 2016).

Drug screening revealed a high degree of correct drug use reporting (about 70% intermethod overlap). In addition, there was over- and underreporting (Hornegger, 2024). Under certain conditions, subjects may be motivated to present a negative image of themselves, for example to obtain a desired treatment. This can lead to overreporting (Richter & Johnson, 2001). Underreporting can be caused by the concern that criminal sanctions or other negative consequences, such as termination of treatment, will follow a truthful statement (Darke et al., 1998; Johnson & Fendrich, 2005; Napper et al., 2010). The admission of drug use may also be interpreted as treatment failure or negative behaviour, which in turn can alter the validity of self-reports (Zanis et al., 1994). Of course, any statement on over- and underreporting require high sensitivity and specificity of the used laboratory drug tests and decline with longer time gaps between test sampling and interview.

Some limitations of the study need to be considered. Randomized assignment of subjects to treatment group was legally and ethically impossible. Although we adjusted for possible a priori group differences through IPTW, additional group differences may exist. Another limitation is the high number of dropouts after release. The attrition rate was about the same for both groups, but it is possible that there are undetected differences between those who dropped out and those who remained in the study. In addition, most results described are based on self-reports by the participants. The comparison between self-reported drug use and laboratory drug screenings based on saliva samples revealed a high level of agreement (ca. 70%); therefore, we assume that our study subjects answered our questions honestly and truthfully. The remaining 30% of non-agreement may be attributed to misuse of the drug screening tests or advanced degrading processes of the consumed substances. However, we detected no systematic evidence of socially desirability and no fear of negative consequences of their statements.

Conclusion

Opioid use disorder is a severe and enduring dependency. Research is needed to reduce the revolving door effect, where incarcerated people alternate between prison stays and a limited time in the community. One possible strategy for reducing this effect is MOUD. Prison-based MOUD appears to have a significant impact on illicit opioid use in prison and after release and increases treatment after release, which is a protective factor. Unfortunately, the significant advantages of MOUD after 3 to 6 months diminished by 1 year. The MOUD group had a significant disadvantage in terms of disciplinary punishments related to MOUD use while in prison (e.g. refusal to have one's urine tested). Disciplinary punishments were also related to illegal trading of MOUD, which can have detrimental effects on people who use drugs but are not dependent. However, interventions to reduce selling/trading MOUD often result in only small effects (cf. Lösel et al., 2020). Any risk reduction, as was

presented in our HOPE study, is positive. Efforts should be made to enhance access to MOUD and use of MOUD while in custody and in the community.

Funding Open Access funding enabled and organized by Projekt DEAL.

Declarations

Competing interests We have no conflicts of interest with respect to the research, authorship, or publication of this manuscript.

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Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Mark Stemmler is Professor of Psychological Assessment, Quantitative Methods and Forensic Psychology at the Friedrich-Alexander-University Erlangen-Nuremberg (FAU). His work focuses on statistical methods, particularly those of the person-centered approach (e.g. configuration frequency analysis), psychodiagnostic procedures for dementia diagnostics and evaluation research in forensic psychology.

Kerstin Geißelsöder is a postdoctoral researcher at the Department of Psychological Assessment, Quantitative Methods and Forensic Psychology, Friedrich-Alexander-University (FAU) Erlangen-Nuremberg. Her research focuses on offenders and substance use.

Maren Weiss is a professor of Psychology at SRH University, Fürth, Germany. Her research focuses on developmental psychopathology, prevention of externalizing and internalizing disorders, and health psychology.

Mavi Hornegger has a Bachelor of Science in Psychology. She is currently a medical student at the Friedrich-Alexander-University (FAU) Erlangen-Nuremberg. Her research interests encompass forensic psychiatry and psychology.

Johann Endres is a psychologist and head of the Criminological Research Unit of the Bavarian Prison Service. He has done research on criminal recidivism, risk assessment, psychopathy, offender treatment, prison violence, femicide, prison work and related areas.