

Type of medication for opioid use disorder is associated with distinct risk profiles among an urban community sample of people who use opioids

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Abstract

Background

Medications for opioid use disorder (MOUD), such as methadone or buprenorphine, reduce opioid use and mortality. However, many people who use opioids (PWUO) continue to use non-prescription opiates during treatment. Little is known about how engagement in different types of MOUD used may be associated with ongoing drug use patterns, overdose history, and risk profiles. In this study, we examined whether using methadone, buprenorphine, or no MOUD was associated with varying sociodemographic characteristics, substance use behaviors, and overdose experiences among PWUO in Baltimore, Maryland.

Methods

We conducted a cross-sectional analysis of baseline survey data from a community-based study including N = 897 PWUO living in Baltimore. Data were collected between December 2022 and August 2024. Participants were categorized into currently receiving methadone, buprenorphine, or no MOUD. Sociodemographic characteristics, drug use patterns, and overdose history were compared using Pearson chi-square tests of association. Multivariable logistic regression models, adjusted for immutable sociodemographic traits, were used to examine associations between MOUD modality and drug-related outcomes.

Results

MOUD modality differed significantly by race and sex. Those receiving buprenorphine were more frequently Black and less frequently female than those receiving methadone. After adjustment for sociodemographic factors, individuals on methadone had higher odds of weekly injection drug use than those receiving no MOUD (adjusted odds ratio (aOR) 1.59, 95% CI: 1.09–2.34), and lower odds of overdose within the previous six months (aOR 0.62, 95% CI 0.42–0.92). Those on buprenorphine had lower odds of weekly stimulant and opioid co-use than those receiving no MOUD (aOR 0.56, 95% CI: 0.36–0.85), but greater odds of having experienced multiple lifetime overdoses (aOR 1.58, 95% CI: 1.07–2.34). Frequent fentanyl use (weekly or more) was high across all groups.

Conclusions

PWUO receiving differing MOUD modalities had distinct sociodemographic characteristics, drug use behaviors, and overdose histories. These findings suggest that MOUD modality may reflect different treatment trajectories and risk profiles. Harm reduction and treatment interventions should be tailored to the specific needs of individuals receiving different forms of MOUD, including sustained injection-related

harm reduction services within treatments programs and enhanced overdose prevention strategies for people receiving buprenorphine.

Background

Medications for opioid use disorder (MOUD), including methadone and buprenorphine formulations, are established, evidence-based treatments that reduce opioid use and risk of overdose and mortality (1–5). Methadone and buprenorphine, mu-opioid receptor agonists, are common types of MOUD (6, 7). Naltrexone, an opioid receptor antagonist, is also FDA-approved to treat opioid use disorder, though evidence of its efficacy is more mixed than for other MOUD types (8).

Engagement in MOUD among people who use opioids (PWUO) is not uniform. While effectiveness studies on MOUD assess outcomes of abstinence from non-prescribed opioid use and treatment retention (9, 10), many PWUO continue to use opioids while engaged in treatment (11). PWUO engaged in MOUD but using non-prescribed opioids at high rates represent a critical and understudied population still at high risk of overdose and other drug-related harms.

Varying types of MOUD are delivered through systems of care with different regulatory and treatment structures, which impact individual experiences (3, 12). For example, methadone is dispensed at opioid treatment programs (OTPs), which are regulated at the federal level and require regular, often daily, visits to an OTP during which methadone is disbursed under a structured treatment protocol (13). In contrast, buprenorphine is commonly prescribed in office settings, including primary clinics, since its approval for outpatient treatment in the early 2000s (3). Buprenorphine initiation has increasingly been offered in the emergency room setting (14). While accessibility to MOUD has increased in the past decade, with nearly half of OTPs now offering multiple forms of MOUD and expanded buprenorphine prescribing capacity, differences in access, prescribing, and individual preferences continue to persist (15, 16). Structural differences also likely shape who is initiated and able to be retained on varying MOUD treatment types.

Previous literature has compared methadone and buprenorphine with regards to treatment retention and effectiveness, finding that methadone tends to have better treatment retention though both have similar effectiveness among those who remain engaged in treatment (17). Research has also been conducted on varying patient preference for methadone versus buprenorphine, often surrounding prior experiences, desire for accountability and structure, and stigma surrounding methadone clinics (18, 19). However, few studies have assessed how current MOUD use among PWUO may correspond with ongoing drug use patterns, recent overdose history, and use environments.

Prior research has documented significant disparities in access to MOUD types across individual, geographic, and social contexts. Research by Xu et al. documented racial inequities in utilization of MOUD among national samples, noting that buprenorphine is more commonly used among White individuals while methadone is more commonly used among Black individuals (20). A study by Hansen et al. found that the number of people receiving buprenorphine treatment in New York City was unevenly distributed across neighborhoods (21). Buprenorphine uptake was concentrated in areas with higher

socioeconomic status and greater proportions of White residents, while methadone clinics were more likely to be located in lower income areas, with a greater number of residents receiving public assistance or subsidies (21). These findings highlight how structural and socioeconomic contexts shape MOUD availability and uptake. There is a dearth of national-level research examining differences between individuals receiving methadone versus buprenorphine treatment (22).

In addition to structural barriers, individual preferences, drug use patterns and behaviors, and treatment dosage and experiences likely influence engagement with MOUD. While existing literature evaluates MOUD effectiveness based on retention or drug-related outcomes (9), significant gaps exist on how sociodemographic characteristics, drug-related behaviors, and overdose experiences vary across individuals who engage in different forms of MOUD or no MOUD. A recent national study found that approximately 86% of individuals with OUD may benefit from MOUD but do not receive it (23). These gaps are particularly important, given the high burden of overdose morbidity and mortality among PWUO. If MOUD types are differentially accessed by individuals with varying risk profiles and drug-related vulnerabilities, interventions that fail to account for these differences will not be maximally effective for those at highest risk of overdose or adverse drug-related outcomes.

Additionally, this study takes place in Baltimore City, MD, a city with historically high rates of opioid use disorder and overdose fatality (24). In the past decade, policy initiatives in Baltimore, including expansion of state Medicaid to cover outpatient substance use treatment and buprenorphine initiation within drug counseling programs, have ameliorated difficulties in access to methadone and buprenorphine (18). Compared with other urban cities, lower-income individuals with opioid use disorder in Baltimore have increased access to publicly funded treatment with both methadone and buprenorphine (18). Federal and multiple state OTP policies and Medicaid coverage for methadone have also changed during this time (25, 26).

In this study, we examined whether current MOUD status (buprenorphine, methadone, or no MOUD) was associated with sociodemographic factors, drug use patterns, locations of drug use, or overdose history among PWUO in an urban setting with comparatively robust availability of treatment services for MOUD. We hypothesized that individuals in methadone treatment may have attributes suggesting more severe or long-standing opioid use disorder, such as injection behavior or older age, than their buprenorphine or no-MOUD counterparts (21). We also expected those currently engaged in methadone or buprenorphine to differ from one another based on sociodemographic and structural differences in treatment access, such as race, gender, and use location. Other associations were examined in a more exploratory manner. In characterizing differences between individuals with varied MOUD engagement, this study seeks to inform more tailored and person-centered harm reduction, overdose prevention, and treatment engagement strategies.

Methods

Data

Data come from the Oasis study, a research project on understanding geospatial correlates of drug use and promoting engagement in risk reduction among people who use drugs. Additional details about the Oasis study are published elsewhere. In short, the study takes place at a community-based research center in Baltimore, Maryland. Eligible participants were 18 years or older, lived in the Baltimore Metropolitan area, and indicated using opioids like heroin, fentanyl, or prescription opiates to get high within the past month. All participants provided verbal consent to participate in the study. The study was approved by the Johns Hopkins Bloomberg School of Health Institutional Review Board.

All participants completed a baseline quantitative survey facilitated by trained interviewers. The survey included questions on sociodemographic and health information, substance use frequency and characteristics, current use of MOUD and type, experiences using drugs in different settings, overdose history, and locations of most frequent drug use. Participants were recruited between December 2022 and August 2024. Recruitment strategies included the dissemination of flyers sent to various local community organizations and street-based recruitment. Prior study participants at the research center were also contacted and informed that they may be eligible for new studies.

Measures

All data used in this cross-sectional study come from the baseline survey. In this analysis, the primary outcome of interest was a three-category variable indicating whether the client was (a) taking methadone for treatment of opioid use disorder (OUD), (b) taking buprenorphine for OUD treatment, or (c) not taking any medication for OUD treatment (subsequently referred to as “no MOUD”). This variable was assessed with the categorical question: “Are you currently taking any of the following medications to treat drug addiction?” Response categories included: “Methadone,” “Buprenorphine/Suboxone,” “Naltrexone,” “Some other medication,” or “None of these.” Selecting “Some other medication” gave participants the option to complete a free response. Only two participants (0.2%) endorsed concurrent use of both methadone and buprenorphine and were omitted from the analysis to increase interpretability of differences between main outcome groups. Three participants (0.3%) endorsed only using naltrexone and were likewise removed from the current analysis, leaving a final sample size of $N = 897$ out of 903 individuals who completed the baseline survey. Twelve participants responded, “Some other medication,” and provided free response answers. None of the free response answers included methadone or buprenorphine and were subsequently coded as “No MOUD.”

Sociodemographic variables included age, sex assigned at birth, race/ethnicity, employment status, education level, and current homelessness. Age was condensed into a categorical variable based on cutoff thresholds from the National Health and Nutrition Examination Survey: 20–29 years, 30–39 years, 40–49 years, 50–59 years, and 60 years or older (27). Other sociodemographic variables included employment (“Employed/Retired,” “Unemployed,” or “Disabled/Unable to work”) and educational attainment (“Less than Grade 12,” “Grade 12 or GED,” or “Some college”). Health variables included HIV status, having ever tested positive for Hepatitis C, current homelessness, and Center of Epidemiologic

Studies Depression Scale (CESD-10) score, for which the threshold was a score of 10 or greater indicating depressed mood (28). All health variables were binary (yes/no).

Variables relating to drug use patterns included: past three-month frequency of heroin, fentanyl, prescription opiate use, crack, powdered cocaine, methamphetamines, and frequency of injection drug use. Categories for frequency of opiate use or co-use included: “Never or over one year ago,” “Over one month ago,” “Within the past month,” “Within the past week,” and “Within the past day” and were consolidated into a binary categorization of “Weekly or more” versus “Less than weekly.” Response options for injection drug use in the past six months included “Never,” “Less than monthly,” “Monthly,” “Weekly,” “Daily or almost daily,” and were consolidated into binary categories of “Less than weekly,” and “Weekly or more.”

Survey items related to overdose characteristics included number of times ever overdosed and recency of last overdose. Number of times ever overdosed was assessed as a free response question and was subsequently recoded into a binary category representing experiencing an overdose more than once (“No” or “Yes”). Recency of last overdose categories were consolidated into a binary variable representing whether the participant had overdosed in the past six months (“No” or “Yes”). Questions related to use locations included description of location of most frequent past-month drug use (Response Categories: “My own house,” “Someone else’s house,” “Street,” “Alley,” “Park,” “Public bathroom,” “Abandoned building,” “Car,” or “Other,” and collapsed into the following binary categories: “House (Self or Other)” and “Outside of Home”.

Analytic Approach

Sociodemographic variables were tabulated and compared by current MOUD type. Categorical predictor variables, including socio-demographics, drug use patterns, behaviors, and locations, and overdose history, were compared using Pearson’s chi-square test. Fisher’s Exact test as used in cases where expected cell counts were less than 5.

A series of logistic regression models were used to examine associations between drug use and overdose patterns and MOUD types, after controlling for more stable characteristics that could systematically influence the behavioral outcomes such as age, race, gender, employment, education, current homelessness, and living with HIV. Multivariate logistic regression was conducted for all binary outcomes: frequency of fentanyl use, heroin use, prescription opiate use, stimulant and opiate co-use, injection weekly or more in past three months, location of most recent use, experiencing more than one overdose, and overdose within the past six months). All analyses were conducted using STATA 19.0.

While formal a priori power calculations were not calculated for this study, we evaluated the appropriateness of this data for the suggested regression analyses using the concept of events per variable (EPV) (29), which is defined for multinomial models as the number of observations in the smallest outcome category divided by the number of regression parameters. A common threshold is an

EPV of at least 10, though research also suggests that the number of EPV can be relaxed when adjusting for confounders (e.g., 5–9 EPV) while others suggest a goal EPV around 20 (30, 31). The breakdown by MOUD type in our sample is: no MOUD (n = 456, 50.8%), methadone (n = 285, 31.8%), and buprenorphine (n = 156, 17.4%). Thus, given that the smallest outcome category is buprenorphine (n = 156), we considered parsimony and theoretical relevance of variables when selecting predictors to aim for a rough EPV between 10–20.

Results

Table 1 shows sociodemographic characteristics of the sample. 37.4% were between ages 50–59, 68.3% were black, and 59.9% reported male gender. 45.0% were unemployed and 40.5% were unable to work, while 16.2% of the sample reported currently living on the streets or in a shelter at the time of the survey.

Table 1
Sociodemographics of Full Sample and Comparisons by MOUD Type (N = 897)

	Full Sample (N = 897)	No MOUD (n = 456, 50.8%)	Methadone (n = 285, 31.8%)	Buprenorphine (n = 156, 17.4%)	Pearson Chi^2 (p- value)
	n(%) or Mean(SD)				
Sociodemographics					
Age (Years)*					χ ² (8) = 12.1, p = 0.147
20–29	46 (5.1%)	27 (5.9%)	9 (3.2%)	10 (6.4%)	
30–39	163 (18.2%)	88 (19.3%)	48 (16.8%)	27 (17.3%)	
40–49	183 (20.4%)	81 (17.8%)	59 (20.7%)	43 (27.6%)	
50–59	335 (37.4%)	169 (37.1%)	116 (40.7%)	50 (32.1%)	
60 and older	170 (19.0%)	91 (20.0%)	53 (18.6%)	26 (16.7%)	
Race					χ ² (4) = 30.7, p = 0.000
Black	613 (68.3%)	327 (71.7%)	164 (57.5%)	122 (78.2%)	
White	232 (25.9%)	104 (22.8%)	105 (36.8%)	23 (14.7%)	
Other	52 (5.8%)	25 (5.5%)	16 (5.6%)	11 (7.15)	
Gender					χ ² (2) = 7.36, p = 0.025
Male	537 (59.9%)	282 (62.0%)	153 (53.7%)	102 (65.4%)	
Female	359 (40.1%)	173 (38.0%)	132 (46.3%)	54 (34.6%)	
Employment					χ ² (4) = 3.16, p = 0.531

	Full Sample (N = 897)	No MOUD (n = 456, 50.8%)	Methadone (n = 285, 31.8%)	Buprenorphine (n = 156, 17.4%)	Pearson Chi^2 (p- value)
	n(%) or Mean(SD)				
Sociodemographics					
Employed/Retired	130 (14.5%)	67 (14.7%)	35 (12.3%)	28 (18.0%)	
Unemployed	403 (45.0%)	209 (45.9%)	129 (45.3%)	65 (41.7%)	
Disabled/Unable to work	363 (40.5%)	179 (39.3%)	121 (42.5%)	63 (40.4%)	
Education					χ ² (4) = 3.38, p = 0.497
Less than Grade 12	271 (30.2%)	143 (31.4%)	84 (29.5%)	44 (28.2%)	
Grade 12 or GED	389 (43.4%)	188 (41.2%)	124 (43.5%)	77 (49.4%)	
Some college or more	237 (26.4%)	125 (27.4%)	77 (27.0%)	35 (22.4%)	
Currently homeless	145 (16.2%)	76 (16.7%)	45 (15.8%)	24 (15.4%)	χ ² (2) = 0.20, p = 0.906
Health Characteristics					
Living with HIV	68 (7.7%)	41 (9.2%)	16 (5.7%)	11 (7.1%)	χ ² (2) = 3.12, p = 0.210
CESD-10 Score ≥ 10	622 (69.3%)	314 (68.9%)	195 (68.4%)	113 (72.4%)	χ ² (2) = 0.87, p = 0.649

Race was significantly associated with MOUD modality ($\chi^2(4) = 30.7, p = 0.000$). More participants currently on buprenorphine were Black (78.2%) compared with 57.5% of those on methadone; a greater proportion of those on methadone were White (36.8%) compared with those on buprenorphine (14.7%). Gender was associated with MOUD modality; 46.3% of those methadone were female compared with buprenorphine (34.6%) or no MOUD (38.0%).

Table 2
Comparing Drug Use Patterns, Locations, and Overdose History by MOUD Type (N = 897)

Drug Use Patterns	No MOUD (n = 456, 50.8%)	Methadone (n = 285, 31.8%)	Buprenorphine (n = 156, 17.4%)	Pearson Chi ² (p-value) or Fisher's Exact
Frequency of fentanyl use				$\chi^2(2) = 9.06, p = 0.011$
<i>Weekly or more</i>	328 (72.4%)	233 (82.0%)	116 (74.4%)	
<i>Less than weekly</i>	125 (27.6%)	51 (18.0%)	40 (25.6%)	
Frequency of heroin use				$\chi^2(2) = 2.66, p = 0.265$
<i>Weekly or more</i>	351 (77.3%)	225 (79.2%)	113 (72.4%)	
<i>Less than weekly</i>	103 (22.7%)	59 (20.8%)	43 (27.6%)	
Frequency of prescription opiate use				$\chi^2(2) = 0.50, p = 0.779$
<i>Weekly or more</i>	68 (15.0%)	43 (15.1%)	27 (17.3%)	
<i>Less than weekly</i>	385 (85.0%)	241 (84.9%)	129 (82.7%)	
Frequency of stimulant and opiate co-use				$\chi^2(2) = 6.97, p = 0.031$
<i>Weekly or more</i>	178 (39.0%)	114 (40.0%)	44 (28.2%)	
<i>Less than weekly</i>	278 (61.0%)	171 (60.0%)	112 (71.8%)	
Frequency of injecting drugs				$\chi^2(2) = 13.3, p = 0.001$
<i>Weekly or more</i>	114 (25.1%)	105 (37.0%)	39 (25.0%)	
<i>Less than weekly</i>	340 (74.9%)	179 (63.0%)	117 (75.0%)	
Drug Use Locations				
Location of most frequent past-month drug use				
<i>House (Self or Other)</i>	275 (60.6%)	176 (61.8%)	94 (60.3%)	$\chi^2(2) = 0.13, p = 0.94$
<i>Outside of Home</i>	179 (39.4%)	61 (38.3%)	62 (39.7%)	

Drug Use Patterns	No MOUD (n = 456, 50.8%)	Methadone (n = 285, 31.8%)	Buprenorphine (n = 156, 17.4%)	Pearson Chi^2 (p-value) or Fisher's Exact
Overdose History				
Experienced more than one overdose				$\chi^2(2) = 2.87, p = 0.24$
Yes	153 (33.6%)	103 (36.1%)	64 (41.0%)	
No	303 (66.5%)	182 (63.9%)	92 (59.0%)	
Overdosed in past 6 months				$\chi^2(2) = 7.08, p = 0.029$
Yes	111 (24.4%)	51 (17.9%)	44 (28.2%)	
No	344 (75.6%)	234 (82.1%)	112 (71.8%)	

In bivariate Chi-squared analyses, frequency of fentanyl use differed by MOUD modality ($\chi^2(2) = 9.06, p = 0.011$); 82.0% of those on methadone reported fentanyl use weekly or more compared with 72.4% of those not on MOUD and 74.4% of those on buprenorphine. Stimulant and opiate co-use frequency also differed by MOUD modality ($\chi^2(2) = 6.97, p = 0.031$), with those on buprenorphine reporting lower rates of co-use weekly or more (28.2%) compared with those on no MOUD (15.0%) or methadone (15.1%). Frequency of injection drug use differed by MOUD modality ($\chi^2(2) = 13.3, p = 0.001$); 37.0% of those on methadone reported injecting drugs weekly or more in the past 3 months compared with those on buprenorphine (25.0%) or those not on MOUD (25.0%). There were also significant differences by MOUD modality in past six month overdose ($\chi^2(2) = 7.08, p = 0.029$). More participants on buprenorphine reported an overdose in the past six months (28.2%) compared with no MOUD (24.4%) or methadone (17.9%).

Associations between drug use and overdose outcomes and MOUD type, adjusted for sociodemographic factors, are shown in Table 3 below.

Table 3

Multivariate Regression Models Assessing Drug Use and Overdose Patterns by MOUD Type, Adjusting for Sociodemographic Factors (N = 897)

Frequency of fentanyl use	Methadone vs. No MOUD Adjusted Odds Ratio* (aOR) (95% CI)	Buprenorphine vs. No MOUD aOR* (95% CI)	Methadone vs. Buprenorphine aOR* (95% CI)
<i>Weekly or more</i>	1.45 (0.98, 2.15)	1.22 (0.79, 1.89)	1.19 (0.72, 1.98)
<i>Less than weekly</i>	REF	REF	REF
Frequency of heroin use			
<i>Weekly or more</i>	1.09 (0.74, 1.59)	0.77 (0.50, 1.18)	1.42 (0.88, 2.29)
<i>Less than weekly</i>	REF	REF	REF
Frequency of prescription opiate use			
<i>Weekly or more</i>	1.17 (0.75, 1.83)	1.06 (0.64, 1.77)	1.11 (0.63, 1.95)
<i>Less than weekly</i>	REF	REF	REF
Frequency of stimulant and opiate co-use			
<i>Weekly or more</i>	0.91 (0.65, 1.27)	0.56 (0.36, 0.85)	1.64 (1.03, 2.60)
<i>Less than weekly</i>	REF	REF	REF
Frequency of injecting drugs			
<i>Weekly or more</i>	1.59 (1.09, 2.34)	1.15 (0.71, 1.87)	1.39 (0.83, 2.31)
<i>Less than weekly</i>	REF	REF	REF
Drug Use Locations			
Location of most frequent past-month drug use			
<i>House (Self or Other)</i>	0.92 (0.66, 1.30)	1.02 (0.68, 1.54)	0.90 (0.58, 1.42)
<i>Outside of Home</i>	REF	REF	REF
Overdose History			
Experienced more than one overdose			
* Adjusted for age, race, sex, employment, education, current homelessness, and HIV status			

Frequency of fentanyl use	Methadone vs. No MOUD Adjusted Odds Ratio* (aOR) (95% CI)	Buprenorphine vs. No MOUD aOR* (95% CI)	Methadone vs. Buprenorphine aOR* (95% CI)
Yes	1.04 (0.75, 1.44)	1.58 (1.07, 2.34)	0.66 (0.43, 1.01)
No	REF	REF	REF
Overdosed in past 6 months			
Yes	0.62 (0.42, 0.92)	1.23 (0.80, 1.88)	0.51 (0.31, 0.82)
No	REF	REF	REF
<i>* Adjusted for age, race, sex, employment, education, current homelessness, and HIV status</i>			

Methadone vs No MOUD

Compared to those not using MOUD, participants on methadone had 1.52x greater odds of injecting weekly or more (aOR 1.59, 95% CI: 1.09–2.34). Participants on methadone had lower odds of experiencing an overdose in the past six months (aOR 0.62, 95% CI: 0.42–0.92). There was no significant association between frequency of opioid use and MOUD type after adjusting for sociodemographic variables.

Buprenorphine vs No MOUD

Individuals using buprenorphine had lower odds of stimulant and opiate co-use than people not on MOUD (aOR 0.56, 95% CI: 0.36–0.85). Those using buprenorphine had 58% increased odds of having overdosed more than once than people not on MOUD (aOR 1.58, 95% CI: 1.07–2.34).

Methadone vs. Buprenorphine

Participants on methadone had 64% increased odds of stimulant and opiate co-use weekly or more compared with those on buprenorphine (aOR 1.64, 95% CI: 1.03–2.60). Individuals on methadone were less likely to have experienced overdose in the past six months, compared with those on buprenorphine (aOR 0.51, 95% CI: 0.31–0.82).

Discussion

In this study, we identified differences in sociodemographic factors, drug use patterns, and overdose history among those using buprenorphine, methadone, or not receiving MOUD. Key sociodemographic differences emerged between people who received buprenorphine or methadone, which is consistent with prior literature that engagement in methadone versus buprenorphine is shaped by structural factors (21, 23, 32).

MOUD was significantly associated with race, with more Black and male individuals on buprenorphine or no MOUD compared with methadone. While prior literature has found that buprenorphine is more commonly used among White populations (21), our findings differ, likely due to the composition of our urban study sample. Employment status among our Black and White participants was similar, with most unemployed or disabled/unable to work; our White study participants do not appear to represent a more affluent population than their Black counterparts. In this urban sample of PWUO, differences in MOUD type by race (with more Black participants on buprenorphine and more White participants on methadone) may be more a marker of opportunities to engage with harm reduction programs, social networks with varying norms surrounding MOUD, or different treatment trajectories. Findings underscore that associations between race and MOUD modality may be strongly dependent on context and shaped by local sociodemographic factors and treatment environments.

In our study, fewer women were enrolled in buprenorphine relative to methadone. Prior studies have identified gender-related barriers to any MOUD engagement due to barriers such as child-care, treatment access, or stigma(33–35). Findings on gender differences among specific types of MOUD are sparse, and gender-based barriers to pursuing different MOUD modalities should be further investigated.

Differences in drug use types and route of administration also emerged between MOUD types. Those on methadone had higher odds of frequent co-use than those on buprenorphine and significantly greater odds of frequent injection drug use than those not on MOUD. Given higher demands for consistent engagement with methadone treatment, and associations with co-use and frequent injection drug use, individuals on methadone may represent a subgroup with more entrenched drug use patterns. Indeed, those currently in methadone treatment may represent a group with prolonged engagement in treatment for OUD, consistent with evidence demonstrating higher treatment retention among those using methadone (36). Results may reflect differences in treatment history and ongoing engagement rather than direct effects from MOUD.

Overdose history also differed across MOUD categories. Participants on methadone had lower odds of past six-month overdose than those on buprenorphine or not on MOUD, while those on buprenorphine had greater odds of having experienced more than one overdose. Methadone treatment may increase exposure to harm reduction resources, including overdose education and naloxone (37–39). Given that buprenorphine use was associated with having experienced more than one overdose, it is possible that this younger subgroup represents individuals with lower treatment stability or retention (36, 40) or recent overdose prompting initiation of MOUD (41). Given the potency of fentanyl, insufficient dosing with buprenorphine may also be an issue (42).

Altogether, findings have important implications for public health practice and intervention design. Individuals engaged in different forms of MOUD likely require different forms of tailored outreach and retention support. While certain interventions – such as applied contingency management approaches or optimization of buprenorphine dosing – may have broad benefits among PWUO (43, 44), a one-size-fits-all approach to treatment engagement is unlikely to be maximally effective in PWUO. Rather, current MOUD modality appears to be associated with varying population attributes and risk profiles, suggesting that interventions should also be stratified accordingly and involve shared decision-making (45).

Those engaged in methadone treatment appeared to report more frequent injection drug use and stimulant and opioid co-use, suggesting a need for sustained harm reduction strategies offered in treatment settings, such as drug testing, safe injection resources, and appropriate infectious disease testing and prevention. Strategies may include increased access to sterile injection equipment and routine screening and linkage to care for infectious. Given the higher frequency of in-person visits at methadone clinics, OTP settings might also serve as critical locations to deliver co-located services integrating substance use care, infectious disease treatment, and comorbid health conditions.

In contrast, individuals on buprenorphine, who showed greater associations with recent overdose and having experienced more than one overdose, could benefit from interventions that target overdose prevention education, support access to harm reduction resources, and encourage treatment continuity. Such interventions could include peer navigation and real-time monitoring strategies including mHealth initiatives (46, 47).

It is important to note that people who received no MOUD still had high rates of stimulant and opioid co-use. Fentanyl use weekly or more was high among all three groups (72–82% prevalence), suggesting a high level of baseline overdose vulnerability on which additional risk factors are layered. Findings strongly emphasize the value of linkage to treatment strategies to engage PWUO who may benefit from MOUD, such as linkage to MOUD initiation in emergency room or acute care settings (48). Findings also highlight the importance of aligning intervention strategies with person-specific needs and drug-related vulnerability to improve treatment engagement and reduce overdose mortality.

Several limitations should be considered. Because this study is cross-sectional and observational, we cannot draw causal inferences between MOUD type and variables like drug use patterns. Further, there may be structural factors that affect MOUD selection (e.g., treatment accessibility, insurance coverage, provider availability) that are not measured or represented in this study. Another potential threat to validity is measurement error. Study questions assess current MOUD status but do not include data on duration of treatment, dosing, adherence, or past MOUD experiences. As OUD treatment is often episodic, participants may have switched between multiple forms of MOUD and/or no MOUD (40).

There may be biases in the sampling procedures. Participants were recruited through a community-based research center and may preferentially be those previously amenable to harm reduction services, including drug treatment. Individuals were also only eligible if they were actively using opioids, though many were also using stimulants, and thus they may differ demographically or behaviorally from people

who only use opioids. Adulterants in the drug supply, such as xylazine, may complicate the interpretation of engagement with MOUD, as these substances can produce withdrawal symptoms not addressed by MOUD alone. We did not measure exposure to such adulterants, which may influenced treatment experience and overdose risk. There may be other unmeasured confounders, such as duration and severity of opioid use disorder and prior treatment history. Also, given that this was an exploratory study, we did not adjust for multiple comparisons. Subsequent studies with preplanned hypotheses should be conducted to confirm the identified associations (49).

Conclusions

Despite these limitations, the study contributes to sparse literature on correlates of MOUD engagement within a community sample of PWUO. In this study, MOUD modality was associated with race, gender, injection drug use, stimulant co-use, and overdose history. Indeed, current MOUD engagement may reflect different risk profiles surrounding drug use that should directly inform and shape targeted and more equitable harm reduction and intervention strategies for PWUO.

Future research should focus on longitudinal measures of treatment engagement, delineating treatment episodes by duration of MOUD use, lifetime MOUD history, switching between MOUD types, and barriers and facilitators to initiation, retention, and disengagement. Future survey items could include more details questions about MOUD dosage, route of administration (e.g., sublingual or injection), missed doses, or methadone take-homes vs. onsite administration. Research may also assess structural factors that might impact treatment access and retention, such as perception of treatment adequacy and access to various services. Perceptions of MOUD efficacy, particularly in the setting of an evolving drug supply, should also be studied. Finally, qualitative work on individuals' past experiences with MOUD, personal preferences, and factors influencing their choice between MOUD options may enrich our understanding of how, when, and why individuals engage with different MOUD modalities, ultimately supporting harm reduction efforts and interventions to increase initiation and retention in potentially lifesaving MOUD options among PWUO.

Abbreviations

aOR
adjusted odds ratio
EPV
events per variable
MOUD
medications for opioid use disorder
OTP
opioid treatment program
OUD
opioid use disorder

Declarations

Ethics approval and consent to participate: The study was conducted in accordance with the Declaration of Helsinki and approved by the Bloomberg School of Public Health Institutional Review Board Approval Code: IRB # 19139, FWA #00000287, Approval Date: 28 March 2022. Informed consent was obtained from all participants involved in the study.

Consent for publication: Not applicable

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. Due to reports of illegal behaviors, the data will be unidentified.

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