



A cohort study examining the relationship among housing status, patient characteristics, and retention among individuals enrolled in low-barrier-to-treatment-access methadone maintenance treatment[☆]

Marina Gaeta Gazzola^{a,b}, Jafin D. Carmichael^c, Lynn M. Madden^{a,d}, Nabarun Dasgupta^e, Mark Befitel^{a,b,f}, Xiaoying Zheng^{a,g}, Kathryn F. Eggert^a, Scott O. Farnum^a, Declan T. Barry^{a,b,f,*}

^a The APT Foundation, New Haven, CT, USA

^b Department of Psychiatry, Yale School of Medicine, New Haven, USA

^c Department of Statistics, the University of Washington, Seattle, USA

^d Department of Internal Medicine, Yale School of Medicine, New Haven, USA

^e Injury Prevention Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

^f Child Study Center, Yale School of Medicine, New Haven, USA

^g Yale University, New Haven, USA

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ABSTRACT

Background: Few studies have directly compared patient characteristics and retention among those enrolled in methadone maintenance treatment (MMT) based on housing status. Low-barrier-to-treatment-access programs may be particularly effective at attracting patients experiencing homelessness into MMT; however, the literature on retention in such settings is limited.

Methods: We performed a retrospective chart review of 488 consecutive patients enrolled from April to October 2017 at low-barrier-to-treatment-access MMT programs in southern New England. Patients completed measures of demographics, social isolation, trauma, chronic pain, smoking behavior, and psychiatric distress. The study investigated associations between housing status and correlates with chi-square and Mann-Whitney *U* tests while controlling the False Discovery Rate. A two-sample log-rank test examined the relationship between retention and housing status. The study further scrutinized this association by regressing retention on all covariates using a Cox proportional hazards model.

Results: Forty-six patients (9.4%) reported experiencing homelessness and 442 (90.6%) reported being housed. Thirty-seven percent of patients self-identified as female and 20% as non-white. Compared to patients who were housed, those experiencing homelessness had lower rates of recent employment; higher rates of social isolation, trauma, current chronic pain, and recent cannabis use; and higher overall psychiatric distress (all $p < 0.01$). At one year, overall retention was 51.8%, and retention was 32.6% in the unhoused group and 53.8% in the housed group. A significant negative association occurred between retention and housing status ($p = 0.006$). After regressing on all covariates, homelessness was associated with a 69% increase in one-year treatment discontinuation (HR = 1.69 for homelessness, CI = 1.14–2.50).

Conclusions: Patients entering MMT experiencing homelessness have multiple clinical vulnerabilities and are at increased risk for 12-month MMT discontinuation. Low-barrier-to-treatment-access MMT programs are an important venue for identifying and addressing vulnerabilities associated with homelessness.

1. Introduction

Increasing methadone maintenance treatment (MMT) access and

retention are important public health strategies for addressing the international opioid crisis (Krausz et al., 2021; WHO, 2021). MMT is an evidence-based treatment for opioid use disorder (OUD) that combines

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* Corresponding author at: APT Pain Treatment Services, 495 Congress Avenue, New Haven, CT 06519, USA.

E-mail address: declan.barry@yale.edu (D.T. Barry).

the opioid agonist methadone with psychosocial services and is associated with decreased opioid use, overdose, and all-cause mortality (National Academies of Sciences, Engineering, and Medicine, 2019). Enhancing MMT access and retention may be particularly important among individuals with OUD who are unhoused.¹ Homelessness is prevalent among persons with OUD and confers increased risk of overdose and overall mortality (Baggett et al., 2013; Fazel et al., 2014; Morrison, 2009; Niflsson et al., 2019). Overdose, particularly from opioids, is a leading cause of death among adults experiencing homelessness (Baggett et al., 2013). However, people experiencing homelessness are less likely to enroll in MMT compared to those who are housed (Corsi et al., 2007; Deck & Carlson, 2004; Eyrich-Garg et al., 2008; McLaughlin et al., 2021; Rivers et al., 2006; Yang et al., 2019) and a paucity of studies systematically compare patient characteristics and retention among individuals who are housed and unhoused entering MMT (Han et al., 2021; McLaughlin et al., 2021). This disparity may be due in part to policies at MMT programs, which limit access and retention among certain vulnerable groups (Gryczynski et al., 2011; Kourounis et al., 2016; Krawczyk et al., 2019; Refsinger et al., 2009; Sharma et al., 2017; Velasquez et al., 2019). Low-barrier-to-treatment-access MMT programs may be effective at enrolling individuals experiencing homelessness or with greater comorbid psychiatric illness (Carter et al., 2019; Kourounis et al., 2016; Noflan et al., 2015). Low-barrier methadone programs aim to reduce common logistical and financial hurdles to receiving and remaining in treatment, such as not requiring abstinence from substances or having flexible attendance policies (Kourounis et al., 2016; Madden et al., 2018; Strike et al., 2013). However, no studies to date have systematically compared characteristics of patients enrolling in flow-barrier-to-treatment-access MMT who are housed and unhoused.

Among individuals receiving MMT, homelessness has been linked with poorer retention (Hufissoud et al., 2012; Kilimas et al., 2018; Lundgren et al., 2007) and earlier return to substance use (Lo et al., 2018; Shah et al., 2006). Surprisingly, no published studies of patients receiving MMT have compared patient characteristics or treatment retention among those who are housed and those who are unhoused. Prior studies showing a relationship between housing status and retention used heterogeneous datasets that cannot control for program-level differences in retention, such as differing fee structures, program policies (e.g., “high” versus “low” barrier), or provision of administrative discharges. Retention in MMT comprises important individual-level and public health-level outcomes since patients who are not retained in MMT face increased risk of blood-borne infections, opioid overdose, and overdose-related and all-cause mortality (Johnson et al., 2020; Krawczyk et al., 2020; Sordo et al., 2017; Tsui et al., 2014). Rates of 12-month MMT retention (a marker of treatment stability) range widely based on patient and program characteristics (O'Connor et al., 2020). The majority of those entering medication for opioid use disorder (MOUD) programs are not retained at 6 months (Krawczyk et al., 2021; Williams et al., 2020).

Logistical and structural factors reduce MMT enrollment among people experiencing homelessness, which informs research on this topic. Multiple regulations and policies inform the dispensing of methadone in the United States (SAMHSA, 2015). Federal regulation requires patients to attend MMT programs at least 6 days per week for supervised methadone dispensing for the first 90 days (SAMHSA, 2015). MMT programs may interpret federal criteria requiring patient stability prior to additional take-home methadone doses after 90 days to mean that patients must have stable housing (SAMHSA, 2020). Retention in MMT can be adversely affected when programs initiate “administrative discharge” for patients who are unable to pay for services or who do not adhere to clinic policies, such as requiring negative urine drug screens or meeting attendance requirements more stringent than those allowed by the

federal government. In some studies, such policies account for 65–75% of premature (e.g., without “completing” treatment) MMT terminations (Proctor et al., 2015; Proctor et al., 2019). Conversely, flow-barrier models of MMT treatment, which do not enact such policies and intentionally minimize program-initiated discharges, can be effective at reaching vulnerable populations, including individuals experiencing homelessness (Carter et al., 2019; Gaeta et al., 2020; Kourounis et al., 2016; Noflan et al., 2015). Thus, examining the association between housing status and retention in MMT programs that are more accessible to people experiencing homelessness—such as those that are flow-barrier-to-treatment-access and frequently use administrative discharges—is important.

Compared to the general population, people experiencing homelessness have increased rates of trauma (Sundin & Baguley, 2015; Taylor & Sharpe, 2008) and chronic pain (Fisher et al., 2013), and have elevated levels of psychological distress (Gefberg & Linn, 1989; Schutt et al., 1994). The rates of trauma and chronic pain and the levels of psychological distress are also elevated in patients receiving MMT in flow-barrier-to-treatment-access programs (Barry et al., 2009; Befitel et al., 2012), which warrants the comparison of such characteristics among patients enrolled in these programs who are unhoused and housed.

The current study examined patients characteristics and retention associated with homelessness among patients enrolling in flow-barrier-to-treatment-access MMT programs. A prior cross-sectional study of patients who have been retained in flow barrier-to-treatment-access MMT suggests this model can attract people who are unhoused into long-term treatment despite increased depressive symptoms compared to their housed counterparts (Gaeta et al., 2020). We hypothesized that compared to patients who were housed at treatment enrollment, patients experiencing homelessness would have higher rates of chronic pain, higher levels of overall psychiatric distress, and lower rates of 12-month MMT retention.

2. Methods

2.1. Study design, recruitment, and setting

We performed a retrospective chart review of a cohort of consecutive patients who were enrolled in MMT from April to December 2017 at the APT Foundation (APT). A trained programmer abstracted study data from patients' medical records. To reduce bias, the programmer was blinded to study aims and not involved in any other aspects of the research process. Of the 598 patients enrolled during the study period, the current study included 488; 10 patients did not complete the questionnaires because they did not read or write English and 100 patients indicated their housing status was neither “housed” nor “unhoused” (see Section 2.2.1). The APT Foundation Board of Directors and the Human Investigations Committee of the Yale School of Medicine approved the study.

APT is a not-for-profit community-based organization headquartered in New Haven, Connecticut. It operates four outpatient MMT programs using an open-access model, whereby prospective patients begin methadone on the same day they present for intake regardless of housing status or ability to pay and are provided real-time access to multiple voluntary treatment options (Madden et al., 2018). APT has a census of approximately 4500 patients receiving MMT and is one of the largest providers of MOUD in southern New England (Madden et al., 2018). Patients' receipt of medication, counseling, and other services at APT are not contingent on payment. Administrative discharges are rare and are reviewed by the clinical directors and require the authorization of the organization's chief executive officer (APT administratively discharged 0 participants during the study period).

¹ The terms “experiencing homelessness” and “unhoused” are used interchangeably in this manuscript.

2.2. Variables and measures

2.2.1. Housing status at enrollment

The study considered patients “unhoused” if they selected “Shelter/ street” and considered them “housed” if they selected “Apartment or House” in response to the question, “Where did you sleep in the past 30 days?” on the 24-item Behavior and Symptom Identification Scale (BASIS-24) (Efisen et al., 2004). The study excluded patients from data analyses who selected other types of housing ($n = 100$), including “halfway house/group home/board and care home/residential center/supervised housing”; “school or dormitory”; “hospital or detox center”; “nursing home/assisted living”; “jail/prison”; or “other.” We excluded these categories given the lack of specificity and heterogeneity in these categories within the BASIS-24. We include data for excluded patients in Supplementary Table 1.

2.2.2. Baseline characteristics

Patients self-reported age, sex, race, ethnicity, education, relationship status, recent employment, student, or volunteering experience, and receipt of disability benefits (Efisen et al., 2004) (Table 1).

2.2.3. Clinical characteristics

Social isolation. The study considered participants to be socially isolated if they selected “no one” in response to the question, “Outside of your treatment providers, what is your main source of social support?” from the BASIS-24 (see below) (Efisen et al., 2004).

Trauma. The study team assessed trauma experience using items regarding personal experience of physical or sexual assault on the Life Events Checklist for DSM-5 (LEC-5), a validated, self-report measure developed by the National Center for PTSD (Weathers et al., 2013).

Chronic pain. We assessed lifetime and current chronic pain by “yes”

Table 1

Baseline characteristics by housing status of 488 individuals enrolling at a low-barrier methadone program.

	Overall (N = 488)	Unhoused (N = 46)	Housed (N = 442)	P Value
Demographics				
Age, mean (SD)	37 (10.5)	37 (10.3)	37 (10.6)	0.996
Female, N (%)	178 (36.5)	16 (34.8)	162 (36.7)	0.996
Race, N (%)				0.855
American Indian or Alaskan native	4 (0.8%)	2 (4.3)	2 (0.4)	
Black or African American	29 (5.8)	4 (8.7)	25 (5.6)	
White/Caucasian	397 (80)	35 (76.1)	362 (80.4)	
Multiracial or other	66 (13.3)	5 (10.9)	61 (13.6)	
Hispanic ethnicity, N (%)	59 (12.1)	5 (10.9)	55 (12.2)	0.996
Highest education, N (%)				0.996
At least high school graduate/ GED	422 (85.1)	40 (87)	382 (84.9)	
Less than high school	72 (14.9)	6 (13)	68 (15.1)	
Ever married, N (%)	77 (15.8)	4 (8.7)	73 (16.5)	0.395
Recent employment N (%)				0.003
Employment for at least 30 h a week	110 (22.5)	1 (2.2)	109 (24.7)	
Employment for 11 to 30 h a week	55 (11.3)	5 (10.9)	50 (11.3)	
Employment for 0 to 10 h a week	29 (5.9)	0	29	
No employment	291 (59.6)	39 (84.8)	252 (57.0)	
Recent experience N (%)				
Student	28 (5.7)	2 (4.3)	26 (5.9)	0.996
Volunteering	23 (4.7)	3 (6.5)	20 (4.5)	0.996
Receiving any type of disability benefits	58 (11.9)	10 (21.7)	48 (10.9)	0.134

Note: GED = General Educational Development test; Bold text indicated p value <0.05. P values have been adjusted for the false discovery rate.

or “no” responses to: “Have you ever experienced physical pain that lasted 3 months or longer?” and “Are you currently experiencing an episode of physical pain that has lasted 3 months or longer?”

Substance use behavior. The study asked participants about frequency of use of cigarettes and electronic cigarettes in the past 30 days and whether they used cannabis in the last 30 days.

Psychiatric distress. Participants completed the BASIS-24, a validated, 24-item self-report measure (scored on a 0–4 scale), measuring six domains: depression, interpersonal relationships, self-harm, emotional lability, psychosis, and substance use. A weighted total score provides an index of “overall psychiatric distress” (Efisen et al., 2004). We report findings for substance use and overall distress only as the “overall” metric contains the other subscales. The study included substance use as severity of substance use disorder (SUD) might impact treatment retention.

2.2.4. Retention

We defined retention in treatment as continued receipt of methadone doses based on APT electronic medical record data. The study considered patients to be “retained” at each time interval (30 days, 60 days, 90 days, 180 days, 360 days) if they attended treatment appointments without discontinuing treatment. Consistent with state regulations that require outpatient substance use treatment programs to discharge patients who miss 30 days of treatment, the study considered study patients who missed 30 consecutive methadone dispensing appointments as “discontinued” from treatment. A patient who returned to APT after discontinuing treatment was considered to have begun a new treatment episode. During the study period, forty-one total participants discontinued treatment and subsequently began a new treatment episode. For study purposes, we considered these participants to have discontinued treatment at the first time point and did not re-add them to the study when calculating subsequent retention.

2.3. Statistical analysis

The details of the data-preprocessing can be found in the publicly released github repository linked in Section 2.3.3. The study team handled missing values depending on analysis type. For the housing status versus covariates pairwise analysis, we dropped missing values before running each test. For the survival analysis, however, dropping observations with missing values would remove the entire observation; thus we used five nearest neighbor imputation to create an imputed dataset with no missing values for this analysis (Troyanskaya et al., 2001). Missing data counts are included in the supplementary material.

2.3.1. Pairwise analysis

To understand differences between the unhoused and housed groups, we ran difference in distribution tests for demographic and clinical variables. We evaluated categorical variables with a χ^2 test and evaluated continuous variables using a two-sided Mann–Whitney U test. After computing raw p -values for each of these 20 tests, we applied the Benjamini–Hochberg (BH) procedure to control the False Discovery Rate, producing adjusted p -values (Benjamini & Hochberg, 1995). All statements about statistical significance are based on adjusted p -values. We conducted the analysis in python and made use of the *statsmodels* (Seabold & Perktold, 2010) and *explore* packages (Carmichael, 2019).

2.3.2. Associations between housing status and retention

We first examined the pairwise association between housing status and retention via a hypotheses test. To address confounding, we further assessed this association via a multivariate regression with all other variables in the analysis. The retention data have interval censoring; thus, we know, for example, whether a patient was not retained between 1 and 30 days but not the exact number of days. To address hypotheses about the association between housing status and retention, we fit a log-rank test for interval censored data using the *interval* package in R (Fay,

1996; Fay & Shaw, 2010; Sun, 1996). To evaluate the same hypotheses while controlling for covariates, we fit a Cox proportional hazards model for interval censored data using the *ALassoSurvIC* package in R (Li et al., 2020). We subsequently conducted an exploratory analysis using BH-adjusted *p*-values from the Cox regression for all covariates to understand which factors were associated with retention.

We also used the following additional standard python libraries: *numpy* (Walt et al., 2011), *pandas* (McKinney, 2011), *matplotlib* (Hunter, 2007), and *sklearn* (Pedregosa et al., 2011) as well as the *tidyverse* package in R (Wickham & Wickham, 2017). The code to reproduce the analysis can be found at https://github.com/fidc9/repro_homelessness_retention_atp. This repository also includes a results folder that contains detailed results information including test statistics and additional descriptive statistics, but not raw data for patient confidentiality reasons.

3. Results

3.1. Differences in demographic and clinical characteristics between patients who were unhoused versus housed

3.1.1. Demographic characteristics

We identified 488 patients with available data during this period, of which 46 (9.4%) were experiencing homelessness and 442 (90.6%) were housed. Table 1 presents baseline demographic characteristics. The average age of the population was 37 years (range 18–69) and 36% of participants were female, 12% were Hispanic, and 20% were non-White. Of the entire population, 85% had at least a high school degree and 84% had never been married. No significant demographic differences existed between the two groups in pairwise analyses, other than those experiencing homelessness were less likely to have worked a paying job in the last 30 days ($p = 0.003$, $\chi^2 = 18.00$).

3.1.2. Clinical characteristics

Table 2 shows the results of pairwise associations between housing status and clinical variables. Compared to those housed at MMT entry, patients who were unhoused had higher rates of social isolation, physical assault, sexual assault, current chronic pain, and recent cannabis use; and higher levels of overall psychiatric distress. The study found no difference in daily cigarette or electronic cigarette use based on housing status.

3.2. Associations between housing status and retention

The median retention for the entire population was at least 365 days. Overall retention was 87.5% at 30 days (80.4% unhoused group vs. 88.2% housed group), 80.3% at 60 days (71.7% unhoused group vs. 81.2% housed group), 74.4% at 90 days (65.2% unhoused group vs. 75.3% housed group), 61.1% at 180 days (43.4% unhoused group vs. 62.9% housed group), and 51.8% at 365 days (32.6% unhoused group vs. 53.8% housed group). According to a log-rank test, there was a statistically significant association between housing status and retention ($p = 0.006$, Sun's Score = 11.38). Fig. 1 shows the Kaplan-Meier estimates for interval censored data for the two groups, demonstrating the patient group experiencing homelessness had lower retention than the housed group. This association holds after accounting for other covariates. After regressing retention on demographic and clinical covariates using a Cox-proportional hazards model, the coefficient for housing status was statistically significant ($p = 0.004$, regression coefficient = 0.52). Experiencing homelessness at treatment entry was associated with lower retention; homelessness had a Hazard Ratio for MMT discontinuation of 1.69 (CI = 1.14–2.50) compared to housed counterparts.

Table 3 contains the results of the regression to explore which covariates were associated with retention. Homelessness was associated with lower retention (adjusted p -value = 0.032), recent cannabis use was associated with higher retention odds (adjusted p -value = 0.032),

Table 2

Clinical Characteristics of 488 housed and unhoused patients at treatment enrollment in a flow-barrier methadone maintenance treatment program.

	Overall (N = 488)	Unhoused (N = 46)	Housed (N = 442)	χ^2	P value
Social support					
No one besides treatment providers, N (%)	48 (9.7)	11 (23.9)	37 (8.2)	11.76	0.005
Trauma experience					
Physical assault, N (%)	192 (39.3)	32 (69.6)	160 (36.2)	13.88	0.0002
Sexual assault, N (%)	126 (25.8)	22 (47.8)	104 (23.5)	7.70	0.003
Chronic pain					
Lifetime chronic pain (N = 483), N (%)	275 (56.3)	30 (65.2)	245 (55.4)	2.37	0.282
Current chronic pain (N = 483), N (%)	200 (40.2)	29 (63.0)	167 (37.8)	11.45	0.005
Substance behavior					
Cannabis use in last 30 days, N (%)	213 (44.1)	30 (66.7)	183 (41.8)	10.25	0.008
Daily electronic cigarette use in last 30 days, N (%)	36 (7.4)	1 (2.2)	35 (7.9)	1.22	0.414
Daily cigarette use in last 30 days, N (%)	374 (76.6)	41 (89.1)	333 (75.3)	3.36	0.149
Psychiatric distress				AUC	P value
Substance use, mean (SD)	2.50 (1.00)	2.74 (0.93)	2.48 (0.98)	2.92	0.17
Overall, mean (SD)	1.48 (0.79)	1.98 (0.73)	1.48 (0.68)	21.507	0.0002

Note: Bold text indicated p value < 0.05. We report AUC scores for the Mann-Whitney tests. *P* values have been adjusted for the false discovery rate.

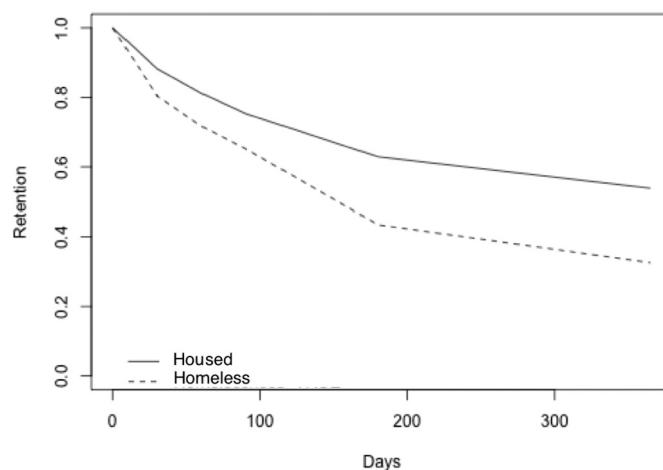


Fig. 1. Interval survival analysis comparing retention over a 12-month period based on housing status.

Note: A log-rank test found the difference between these two groups is statistically significant. The Sun's score test statistics is 11.38.

and any volunteering was associated with lower retention (adjusted p -value = 0.032). No other variables were significantly associated with retention after controlling for multiple testing. We assessed the proportional hazards (PH) assumption for each variable by visual inspection of $\log(-\log(\text{survival}))$ curves. This assumption was satisfied for housing status, but violated for several potential confounding variables (the bold variables in Table 2). To confirm the statistical significance of the

Table 3

Cox proportional hazard model regression for 12-month retention of 488 patients in flow-barrier-to-treatment-access methadone maintenance treatment.

	Hazard ratio	95% CI		Adjusted P value
		Lower	Upper	
Demographics				
Age	0.93	0.81	1.08	0.23
Male sex	0.71	0.52	0.98	0.11
Race	0.93	0.55	1.57	0.41
Hispanic	1.40	0.80	2.46	0.21
At least high school graduate/ GED	1.16	0.77	1.74	0.29
Ever married	0.84	0.58	1.22	0.23
Recent employment				
No employment	1.39	0.75	2.57	0.23
Employment for 11–30 h a week	1.07	0.57	1.99	0.42
Employment at least 30 h a week	0.66	0.36	1.21	0.18
Recent experience				
Student	1.58	1.0	2.48	0.12
Volunteering	2.09	1.22	3.58	0.03
Receiving any type of government benefit	0.69	0.45	1.06	0.13
Experiencing homelessness	1.69	1.14	2.50	0.03
Social Support				
No one besides treatment providers	1.25	0.84	1.87	0.22
Trauma experience				
Physical assault	1.32	0.94	1.87	0.15
Sexual assault	0.76	0.50	1.14	0.18
Chronic pain				
Lifetime chronic pain	1.12	0.77	1.63	0.32
Current chronic pain	0.74	0.51	1.09	0.15
Substance behavior				
Cannabis use in last 30 days	0.68	0.51	0.89	0.03
Daily electronic cigarette use in last 30 days	0.63	0.37	1.06	0.13
Daily cigarette use in last 30 days	1.11	0.77	1.59	0.32
Psychiatric distress				
Substance use	1.18	0.98	1.42	0.13
Overall	0.92	0.77	1.09	0.23

Note: Bold text represents p values <0.05. P values have been adjusted for the false discovery rate.

housing status variable, the team performed a sensitivity analysis by splitting time into two intervals (0–90 and 90–365 days) such that the PH assumption holds within each interval for the potential confounders.

4. Discussion

To our knowledge, this is the first study comparing demographic characteristics, clinical characteristics, and 12-month retention between individuals who were housed and unhoused at flow-barrier-to-treatment-access MMT programs in the United States. The study had two main findings. First, at baseline, compared to patients who were housed, those experiencing homelessness had lower rates of recent employment; higher rates of social isolation, physical assault, sexual assault, recent cannabis use, and current chronic pain; and higher levels of overall psychiatric distress. Second, consistent with the study hypothesis, patients experiencing homelessness were significantly less likely than those who were housed to be retained in treatment at 12 months following intake (32.6% vs. 53.8%), even after controlling for other covariates. These findings suggest patients experiencing homelessness at intake at flow-barrier-to-treatment-access MMT programs have multiple vulnerabilities and are at higher risk of treatment discontinuation.

Close to one fourth of the patients experiencing homelessness in this study reported having no social support outside of their treatment team. Staff at flow-barrier-to-treatment-access MMT programs play an

important social support role in these individuals' lives that goes beyond providing medical care. This finding extends the literature demonstrating decreased social support among different populations experiencing homelessness to include patients with OUD enrolling in MMT (Lam & Rosenheck, 1999; Tsai et al., 2012). Our results align with a prior study that found that patients experiencing homelessness while receiving outpatient buprenorphine had fewer social supports and more contacts with a nurse care manager than their housed counterparts (Ailford et al., 2007). It may be important for MMT programs to address social isolation since it is associated with negative health impacts, including increased mortality (Holt-Lunstad et al., 2010). Peer recovery services, such as support groups, recovery coaches, and mutual aid organizations, might be especially beneficial to patients with OUD experiencing homelessness (Center for Substance Abuse Treatment, 2009). Findings from pilot studies of peer recovery services in people with housing insecurity and SUDs suggest that they generally but not always improve retention, decrease return to substance use, and improve treatment satisfaction and relationships with providers (Eddie et al., 2019). Facilitating access to social work or case management services for patients experiencing homelessness may also enhance sources of social support for this group.

To our knowledge, no published studies on MMT have compared patient characteristics in the domains we examined (e.g., trauma, chronic pain, cannabis use, psychiatric distress) based on housing status. Two prior studies—one comparing retention in office-based buprenorphine treatment (Ailford et al., 2007) and another comparing patient characteristics and treatment entry nationally using a large database of OUD specialty treatment episodes (Han et al., 2021)—are the only studies that have sought to examine patient treatment outcomes based explicitly on housing status, but neither focused on MMT. The high rates of trauma that we found among participants experiencing homelessness, and in particular the high rates of physical assault, extend the literature demonstrating elevated trauma exposure among persons who are unhoused or who have SUDs (Lawson et al., 2013; Taylor & Sharpe, 2008). The finding that participants experiencing homelessness had higher rates of current chronic pain builds off prior studies showing people experiencing homelessness have higher rates of chronic pain than the general population and that homelessness is significantly associated with chronic pain among people who inject drugs (Bicket et al., 2020). The result that homelessness was associated with cannabis use in the past month is consistent with those demonstrating an association between homelessness and co-occurring cannabis use disorder and OUD (De Aquino et al., 2019). While a recent meta-analysis found no evidence for a relationship between cannabis use and reduced use of opioids or treatment retention in MMT, we found cannabis use was significantly positively associated with retention in logistic regression. This finding should be investigated further (McBrien et al., 2019). Although participants experiencing homelessness had higher rates of psychiatric distress, consistent with a prior study, psychiatric distress and MMT retention were not significantly associated (Perreault et al., 2015). Opioid treatment programs, especially those with flow-barrier-to-treatment-access models, are an important point of entry to the health care system for vulnerable individuals, including those experiencing homelessness. Future research should examine how these programs might address the high rates of trauma, chronic pain, cannabis use, and psychiatric distress among patients experiencing homelessness.

Homelessness was independently associated with treatment discontinuation after accounting for potential confounders. Given the low rates of administrative discharges at the study sites, these retention rates reflect patient-initiated treatment terminations, likely influenced by structural factors that warrant further investigation (e.g., transportation access). This finding extends the literature that demonstrates homelessness is one risk factor for poorer retention in MMT by directly comparing patients experiencing homelessness at treatment onset to their housed counterparts in the same treatment setting. Although homelessness is common among patients with OUD, it is understudied in

MMT settings, in part due to barriers to entry for economically disadvantaged individuals in traditional programs (Gryczynski et al., 2011; Krawczyk et al., 2019; O'Gurek et al., 2021). Our work builds off prior studies that have demonstrated a potential association between homelessness and OUD treatment retention by directly comparing participants based on housing status in the same treatment setting. Prior work has shown a significant relationship between treatment discontinuation and earlier return to substance use among people enrolled in methadone treatment (Kilimas et al., 2018; Lo et al., 2018; Lundgren et al., 2007; Shah et al., 2006). Only one prior study, based in Canada, examined housing status and retention among patients receiving flow-barrier methadone; it found no significant association between homelessness and 6-month retention (Perreault et al., 2008). In a previous cross-sectional study at APT that used a different cohort of patients receiving MMT, the mean length of treatment was 24 months among respondents reporting current homelessness, suggesting some patients experiencing homelessness are retained in MMT long-term (Gaeta et al., 2020). Future research, through qualitative or mixed methods, might help us to understand the reasons for MMT discontinuation among patients experiencing homelessness. Future studies should also compare patients experiencing homelessness who remain in MMT to those who discontinue to identify risk factors for discontinuation.

Addressing homelessness along with other social determinants of health may be an important strategy to improving retention in patients enrolling in flow-barrier-to-treatment-access MMT. Placement in supportive housing is associated with increased initiation into SUD treatment and decreased emergency department visits and hospitalizations related to substance use compared to individuals experiencing homelessness not receiving housing (Mittler-Archie et al., 2019). However, some housing intervention models require patients to abstain from substances (whether prescribed or otherwise obtained) and some even bar patients receiving MOUD from receiving services (Bernstefin et al., 2020; Patel et al., 2020). Our results provide an argument for addressing homelessness to improve substance use outcomes for patients with OUD. Multiple studies demonstrate the feasibility of flow-demand or housing first—which do not require abstinence from substances for individuals to secure housing—as strategies to tackle homelessness in people with SUDs, with benefits to both the participants and the health care system (Appel et al., 2012; Davidson et al., 2014; Edens et al., 2011; Larimer et al., 2009; Padgett et al., 2006), including one study showing methadone treatment but not “detoxification” or inpatient treatment decreased discharge from supportive housing (Haffl et al., 2020). While at least one study did not see differences in MMT adherence in a housing first intervention for patients with severe mental illness and OUD on MMT, more work should examine the effects of housing on patients with OUD (Parpouchi et al., 2018). Shelter-based provision of MOUD and mobile treatment facilities have also been shown to be efficacious at engaging patients experiencing homelessness and OUD in evidence-based treatment (Carter et al., 2019; Chatterjee et al., 2017; Haffl et al., 2014; O'Gurek et al., 2021; Regis et al., 2020); further research should investigate the effects of these and other innovative programs (both as stand-alone interventions or in conjunction with flow-barrier-to-treatment-access MMT programs) on promoting retention. Currently APT does not offer formal case management services or alter its clinical approach to patients based on housing status, though counseling services often include discussions about housing, transportation, and insurance acquisition. Generally, MMT programs are not reimbursed for case management. Investigating methadone program-based interventions to assist patients experiencing homelessness connect with housing and remain in treatment are important future directions for research.

4.1. Limitations

Our study has several limitations. We drew our sample from one treatment organization in New England, and thus our findings may not

generalize to other settings. The sample size of the group experiencing homelessness was small relative to the housed group. Future research should replicate our findings in other settings and among larger samples. Our dataset was limited by information available as part of patients' normal clinical course at our programs, thus we may not have examined all factors associated with homelessness and/or retention. Our study did not allow for investigation of housing status chronicity (e.g., whether patients who were temporarily unhoused differed from chronically unhoused patients) or changes (e.g., whether members of the group that were housed at MMT enrollment subsequently experienced homelessness during the one-year study period). Prior work suggests that among individuals with SUDs, those experiencing chronic homelessness have more complex clinical vulnerabilities and worse mental health-related quality of life than those experiencing transient homelessness or those who are housed (Kertesz et al., 2005). Thus, future research should investigate the impact of different trajectories of homelessness on MMT retention and of MMT enrollment on housing stability.

5. Conclusion

Patients experiencing homelessness at entry into flow-barrier-to-treatment-access MMT programs have decreased recent employment and higher social isolation, trauma, chronic pain, cannabis use, and overall psychiatric distress compared to their housed counterparts. Similar to prior studies in traditional MMT settings, homelessness is an independent risk factor for decreased 12-month retention in flow-barrier MMT. Addressing this social determinant of health and the associated clinical vulnerabilities may be important targets for MMT program managers and providers. Providers in flow-barrier-to-treatment-access MMT programs may play a key role in serving the needs of patients experiencing homelessness and should consider how to further assess and address the complex barriers and vulnerabilities that patients experiencing homelessness face.

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The findings of this study were presented in part at the 83rd Annual Scientific Meeting of the College on Problems of Drug Dependence, which occurred virtually in June 2021.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jsat.2022.108753>.

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