Higher perceived stress during admission is associated with shorter retention in short-term residential substance use disorder treatment

Orrin D. Ware [a],*, Paul Sacco [b], John G. Cagle [b], Jodi J. Frey [b], Fernando A. Wagner [b], Alexandra S. Wimberly [b], Bernard Gyebi-Foster [c], Mayra Diaz [c], Kisun Peters [c], Sarah E. Zemore [d]

[a] *University of North Carolina at Chapel Hill School of Social Work, United States*
[b] *University of Maryland School of Social Work, United States*
[c] *Tuerk House Inc, United States*
[d] *Alcohol Research Group, United States*

ARTICLE INFO

ABSTRACT

Introduction: Over one million people in the U.S. received residential treatment for a substance use disorder (SUD) in 2020. Longer treatment retention is associated with better outcomes (e.g., reduced substance use). Entering treatment with higher stress may be associated with shorter retention. This paper examines the impact of perceived stress at admission on SUD treatment retention in short-term residential treatment.

Methods: A sample of 271 treatment episodes with admissions between October 2019 and February 2020 were collected from de-identified records of an urban mid-Atlantic adult 28-day short-term residential SUD treatment facility. Treatment completion involved finishing 28 days. Sociodemographic, substance use, perceived stress, and treatment discharge variables were analyzed. Bivariate analyses examined differences between treatment completion and early discharge, and Cox regression investigated the effect of perceived stress on treatment retention with covariates.

Results: The sample was primarily male (73.8%) and non-Hispanic Black (71.6%). A majority used heroin as their primary substance (54.6%) and reported polysubstance use (72.3%). About half (51.3%) completed treatment, and completed an average of 18.7 ($SD = 10.7$) days. Those who prematurely discharged from treatment stayed an average of 8.9 ($SD = 7.0$) days. The Cox regression model found that higher perceived stress (adjusted hazard ratio (AHR) = 1.028; 95% CI = [1.005, 1.053], $p =$.019) and a race/ethnicity other than non-Hispanic Black (AHR = 1.546, 95% CI = [1.037, 2.305], $p =$.033) predicted premature discharge.

Conclusions: Perceived stress at admission is associated with shorter treatment retention. Early stress management interventions may help increase treatment retention.

1. Introduction

In 2020, over 1 million people ages 12 years and older in the U.S. received residential/inpatient treatment for a substance use disorder (SUD) (Substance Abuse and Mental Health Services Administration [SAMHSA], 2021). SUD treatment retention is associated with beneficial outcomes such as a reduction in the frequency of substance use (Daigre et al., 2021; Hser et al., 2004; Hubbard et al., 2003; SAMHSA, 2016; Schuman-Olivier et al., 2014a; Zhang et al., 2003). Reducing substance use among individuals with a SUD also reduces their risks of experiencing substance use-related morbidity and mortality, such as overdose (Hawk et al., 2015). However, the approximately 30% of individuals

who leave SUD treatment prematurely (Lappan et al., 2020) may not experience these positive outcomes. Important individual level factors such as sociodemographic characteristics and stress may impact treatment retention.

1.1. Sociodemographic factors associated with treatment retention

Several factors are associated with treatment retention. Studies have found that younger persons (Baker et al., 2020; Mutter & Ali, 2019; Mutter et al., 2015; Schuman-Olivier et al., 2014b), those with unstable housing and employment (Mutter et al., 2015), and individuals in underserved groups (e.g., marginalized racial/ethnic groups) have lower

---

retention rates in treatment (Saloner & Lê Cook, 2013; Stahler et al., 2016). Knowledge of which sociodemographic characteristics are associated with treatment retention can allow treatment providers to design specific interventions to increase treatment retention among these groups. Alongside sociodemographic factors, clinical factors such as stress may impact treatment retention.

1.2. Stress, substance Use, and treatment

Stress has been described by Lazarus and Folkman (1984) as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (p. 19). Further, perceived stress is defined as "feelings or thoughts that an individual has about how much stress they are under at a given point in time or over a given time period" (Phillips, 2013, p. 1453–1454). Substantial evidence has demonstrated associations between stress and substance use (MacLean et al., 2019; McHugh et al., 2020; Preston et al., 2018a; Preston et al., 2018b; Sinha, 2008). Some individuals use substances as a stress response to cope with stressors (Bornovalova et al., 2012; Buckner et al., 2007; Heggeness et al., 2019; Marshall-Berenz et al., 2011; Wolitzky-Taylor et al., 2018), sometimes referred to as self-medication (Khantzian, 1985).

Treatment, including admission to treatment, is often stressful, particularly when catalyzed by painful or traumatic circumstances such as an overdose (Alinsky et al., 2020; Kilaru et al., 2020; Pollini et al., 2006) or a criminal justice system referral (Pasareanu et al., 2017). Yet even when treatment is not begun under such circumstances, entering a new environment like a residential treatment facility for a SUD can increase clients' stress. Admission to these facilities can involve a variety of new challenges, such as becoming oriented to the facility's rules, treatment schedule, living quarters, staff, and other individuals receiving treatment. Entering residential treatment can also spark anticipatory fears of experiencing craving (Bergeria et al., 2021; Zemore et al., 2021) and withdrawal (Dunn et al., 2019; Summers et al., 2018) after losing access to substances, as other potential stressors (Ware et al., 2022). People who use substances to cope with stress may perceive residential treatment as more stressful than their typical lives with substance use, as their substance of choice is not easily accessible. In sum, not only are SUDs and stress often mutually reinforcing, but entering treatment for SUDs presents many new, unfamiliar stressors beyond the physical and psychological stress of ceasing to use a desired substance.

1.3. Stress and treatment retention

Identifying and mitigating these stressors can be crucial to SUD treatment outcomes, as the amount of stress an individual perceives and their ability to tolerate stressors may affect their likelihood of SUD treatment retention (Ali et al., 2017; Tull et al., 2013). Notably, stress experienced across an individual's lifetime is associated with prematurely discharging from SUD treatment (Darke et al., 2012; Wallen, 1992). Prior studies on perceived stress among persons in the residential SUD treatment setting have found evidence of effects of perceived stress and ways of reducing it among this population. For instance, findings suggest that perceived stress predicts substance craving (Ames & Roitzsch, 2000) and increased stress is associated with lower retention in treatment for women (Rivera et al., 2021), whereas improved life satisfaction (Tang & Chan, 2017) and supportive text messaging may reduce perceived stress (O'Reilly et al., 2019).

However, the effect of perceived stress on treatment retention in short-term residential programs remains understudied. These settings typically serve high-need individuals with limited financial and psychosocial resources. It is therefore important to examine the impact of sociodemographic, substance use, and mental health stressors concurrently on treatment retention. The current study analyzed treatment data from a short-term residential inpatient treatment facility in an

urban area serving primarily African American adults. Given the rising rates of drug overdose deaths among African Americans (Kariisa et al., 2020), providers must understand their experiences to inform culturally appropriate treatment. This study examined the relationship between perceived stress and treatment retention for adults receiving short-term residential treatment for a SUD in an urban area. Based on the strong connection between stress and substance use (MacLean et al., 2019; Ruisoto & Contador, 2019), individuals using substances to cope with stress (Bornovalova et al., 2012; Buckner et al., 2007; Heggeness et al., 2019; Marshall-Berenz et al., 2011; Wolitzky-Taylor et al., 2018), and residential treatment being a potential barrier to easily accessing substances, we hypothesized that higher levels of perceived stress would predict shorter treatment retention.

2. Material and Methods

2.1. Data source

De-identified data were extracted from the electronic health record (EHR) of individuals admitted to an urban mid-Atlantic adult ($\geq$18 years old) 28-day short-term residential SUD treatment facility between October 2019 and February 2020. The original dataset contained 357 cases. An a priori Little's Missing Completely at Random (MCAR) test was conducted using variables included in this study's Cox regression model. The MCAR test provided a value of $p = .69$, suggesting no bias would result from listwise deletion. After excluding cases missing values for variables in the Cox regression model, the study included a sample of $N = 271$ treatment episodes. All study procedures were deemed not human subjects research by the University of Maryland, Baltimore's Institutional Review Board. A data use agreement was signed by the researchers and the SUD treatment facility before obtaining the de-identified data. As part of the agreement, individuals with a sociodemographic characteristic identified in less than 10 cases in the data were included in a group listed as "Other" (e.g., "Other Race and Ethnicity" for races/ethnicities shared by less than 10 individuals in the sample) to further ensure anonymity.

The dataset contains variables captured during treatment admission and treatment discharge. Self-report admission data were entered into the EHR by admission staff in the treatment facility, including counselors, nurses, peer recovery specialists, and social workers. Categorical variables captured during admission were selected from dropdowns in the EHR after admission staff asked individuals entering treatment to identify their response to a corresponding item. Discharge data were added to the EHR after an individual was discharged from treatment. Further details on the measures are described below.

2.2. Sample

Table 1 contains discharge information, sociodemographic characteristics, and substance use characteristics. The sample was primarily non-Hispanic Black (71.6%) and male (73.8%), with an average age of 44.7 years ($SD = 10.8$). Heroin was the primary substance for most of the sample (54.6%). Most of the sample engaged in polysubstance use (72.3%). Most of the sample indicated experiencing recent anxiety (68.6%) and recent depression (67.9%).

2.3. Measures

2.3.1. Sociodemographic characteristics
Sociodemographic variables captured during admission included age, gender, race and ethnicity, educational level, marital status, employment status, and housing status.

Age. Age-in-years in the EHR was calculated when the individual provided their birthdate.

Gender. Gender was a binary variable in the EHR, and included male and female.

Table 1
Sociodemographic and Substance Use Characteristics by Treatment Completion.

Characteristic	Total n (%)	Treatment Complete n (%)	Premature Discharge n (%)	t or χ2 (p)
Sample Size	271 (100%)	139 (100.0%)	132 (100.0%)	
Age, Mean (SD)	44.7 (10.8)	45.6 (10.5)	43.8 (11.2)	−1.4 (0.177)
Days in treatment, Mean (SD)[a]	18.7 (10.7)	28 (0.0)	8.9 (7.0)	−31.9 (<0.001)
Perceived Stress Scale, Mean (SD)[b]	22.1 (7.9)	20.8 (7.6)	23.5 (8.1)	2.8 (0.006)
Age of primary sub first use, Mean (SD)[c]	21.9 (9.2)	22.2 (9.4)	21.5 (9.0)	−0.6 (0.528)
Gender				0.9 (0.345)
Man	200 (73.8%)	106 (76.3%)	94 (71.2%)	
Woman	71 (26.2%)	33 (23.7%)	38 (28.8%)	
Race and Ethnicity				5.7 (0.057)
Non-Hispanic Black	194 (71.6%)	108 (77.7%)	86 (65.2%)	
Non-Hispanic White	67 (24.7%)	28 (20.1%)	39 (29.5%)	
Other Race and Ethnicity	10 (3.7%)	3 (2.2%)	7 (5.3%)	
Education Level				2.0 (0.567)
Less than HS or GED[d]	85 (31.4%)	49 (35.3%)	36 (27.3%)	
Completed HS or GED	131 (48.3%)	63 (45.3%)	68 (51.5%)	
Some college or college degree[e]	55 (20.3%)	27 (19.4%)	28 (21.2%)	
Marital Status				0.4 (0.947)
Divorced	26 (9.6%)	13 (9.4%)	13 (9.8%)	
Married	25 (9.2%)	12 (8.6%)	13 (9.8%)	
Never married	182 (67.2%)	93 (66.9%)	89 (67.4%)	
Other marital status	38 (14.0%)	21 (15.1%)	17 (12.9%)	
Employment Status				2.6 (0.279)
Employed FT or PT[f]	36 (13.3%)	20 (14.4%)	16 (12.1%)	
Unemployed	224 (82.7%)	111 (79.9%)	113 (85.6%)	
Other employment status	11 (4.1%)	8 (5.8%)	3 (2.3%)	
Housing Status				0.3 (0.850)
Private residence	174 (64.2%)	91 (65.5%)	83 (62.9%)	
Unstable housing	86 (31.7%)	42 (30.2%)	44 (33.3%)	
Other housing status	11 (4.1%)	6 (4.3%)	5 (3.8%)	
Recent Anxiety	186 (68.6%)	90 (64.7%)	96 (72.7%)	2.0 (0.157)
Recent Depression	184 (67.9%)	90 (64.7%)	94 (71.2%)	1.3 (0.255)
Primary Substance				2.5 (0.476)
Alcohol	66 (24.4%)	39 (28.1%)	27 (20.5%)	
Cocaine	36 (13.3%)	16 (11.5%)	20 (15.2%)	
Heroin	148 (54.6%)	74 (53.2%)	74 (56.1%)	

Table 1 (continued)

Characteristic	Total n (%)	Treatment Complete n (%)	Premature Discharge n (%)	t or χ2 (p)
Other primary substance	21 (7.7%)	10 (7.2%)	11 (8.3%)	
Polysubstance Use	196 (72.3%)	93 (66.9%)	103 (78.0%)	4.2 (0.041)

Note. Some percentages may not equal 100 due to rounding.
[a] Treatment episodes were complete at 28 days.
[b] Range 0–40.
[c] Age of first use of the primary substance.
[d] HS = High school; GED = General equivalency degree.
[e] College degree included Associates of Arts and higher.
[f] PT = Part time; FT = Full time.

Race and ethnicity. Race and ethnicity were two separate variables that were recoded into one variable. Ethnicity was a binary variable: Hispanic and Non-Hispanic. The race and ethnicity variables were combined into three categories: Non-Hispanic Black, Non-Hispanic White, and Other Race and Ethnicity. Individuals that did not fall into the categories of Non-Hispanic Black or Non-Hispanic White were added to the category Other Race and Ethnicity due to small sample sizes of less than 10. In the final analyses, Non-Hispanic White (n = 67, 24.7%) and Other Race and Ethnicity 10 (3.7%) were combined into the sample category Other Race and Ethnicity to account for the small sample size.

Education level. Education level included three categories: less than a high school (HS) diploma or general equivalency degree (GED), completed HS or GED, and some college or college degree. Individuals who reported having an educational level of some college/college casework (n = 41, 15.1%) and some college degree, including an Associate of Arts, Bachelor of Arts, or Bachelor of Science (n = 14, 5.2%), were recoded as some college or college degree due to small sample size.

Marital status. Marital status included four categories: divorced, married, never married, and other marital status. Individuals who self-identified as separated (n = 20, 7.4%), widowed (n = 14, 5.2%), or another marital status (n = 4, 1.5%) were recoded as other marital status due to small sample size.

Employment status. Employment status included three categories: employed full time (FT) or part time (PT), unemployed, and other employment status. Individuals who reported being employed FT (n = 23, 8.5%) and employed PT (n = 13, 4.8%), were recoded as employed FT or PT due to small sample size. Individuals that did not fall into the categories unemployed or employed FT or PT were added to the category other employment status due to small sample sizes of less than 10.

Housing status. Housing status included three categories: private residence, unstable housing, and other housing status. Individuals who self-identified their housing status as homeless – no shelter (n = 65, 24.0%) and homeless – shelter (n = 21, 7.7%) were recoded as unstable housing. Individuals that did not fall into the categories private residence or unstable housing were added to the category other housing status due to sample sizes of less than 10.

2.3.2. Substance use characteristics

Substance use variables captured during admission included primary substance and polysubstance use.

Primary substance. Primary substance indicates the main substance used in the past 30 days and included four categories: alcohol, cocaine (including crack), heroin, and other primary substance. Individuals with a primary substance other than alcohol, cocaine, or heroin were added to the category other primary substance due to small sample sizes of less than 10.

Polysubstance use. Polysubstance use (indicating whether an individual used multiple substances) included two categories: yes and no. Treatment episodes with a secondary substance in the past 30 days listed

in the EHR were coded as polysubstance use.

2.3.3. Clinical characteristics

Clinical variables captured during admission included recent anxiety, recent depression, and perceived stress.

Recent anxiety. Recent anxiety included two response categories: yes and no. This binary variable was captured in the EHR via admission staff's selected response to the following item: "*Past 30 Day: experienced serious anxiety, tension, inability to relax, unreasonable worry?*" This question in the EMR was adapted from the Addiction Severity Index (McLellan et al., 1992).

Recent depression. Recent depression included two response categories: yes and no. This binary variable was captured in the EHR via admission staff's selected response to the following item, "*Past 30 Day: experienced serious depression, sadness, hopelessness, lack of interest?*" This question was adapted from the Addiction Severity Index (McLellan et al., 1992).

Perceived stress. Perceived stress is a continuous variable calculated via the Perceived Stress Scale (PSS) (Cohen et al., 1983), with possible scores ranging from 0 to 40. The PSS is a 10-item measure that asks about thoughts and feelings related to stress over the past month (e.g., "*In the last month, how often have you felt that you were unable to control the important things in your life?*", "*In the last month, how often have you felt nervous and 'stressed'?*"). Responses use a five-point Likert-type scale ranging from 0 (*never*) to 4 (*very often*). Four of the items are reverse scored and therefore were recoded to align with the rest of the items. The total measure is summed, and lower scores on the measure indicate lower perceived stress. A previous study found this measure has good internal consistency $\alpha \geq 0.70$ (Lee, 2012). The Cronbach's alpha for the PSS in this sample is $\alpha = 0.87$, indicating strong inter-item consistency.

2.3.4. Discharge variables

Discharge variables captured after an individual discharged from treatment included discharge reason and days in treatment.

Discharge reason. Discharge reason included two categories: treatment completed or premature discharge. Individuals in the EHR listed as discharged against medical advice ($n = 116$, 42.8%), administrative discharge ($n = 13$, 4.8%), and other discharge reason ($n = 3$, 1.1%) were recoded as premature discharge.

Days in treatment. Days in treatment is a continuous variable with a range of 0–28. This variable reflected how many days an individual was in treatment from the day of admission to discharge.

2.4. Data analytic plan

All analyses were conducted using IBM SPSS Version 27 (IBM Corp, 2020). Univariate statistics were used to describe the sample. Bivariate statistics were used to examine discharge reason differences.

We used a multivariable Cox regression analysis to examine the effect of perceived stress and covariates on the number of days retained in treatment. The number of days in treatment was used for time, and premature discharge was the event. Perceived stress (continuous) was the primary predictor. Covariates included gender (reference group: Women), race and ethnicity (reference group: Non-Hispanic Black), education level (reference group: Less than HS or GED; selected as the reference since this is a potential proxy variable for lower socioeconomic status), housing status (reference group: Unstable housing; selected as the reference since this is a potential proxy variable for lower socioeconomic status), recent anxiety (reference group: No), recent depression (reference group: No), primary substance (reference group: Heroin; selected as the reference since heroin was the primary substance for a slight majority of the sample), and polysubstance use (reference group: No). While our primary focus was perceived stress, these covariates were included to control for the potential effects of sociodemographic, substance use, and mental health stressors on treatment retention. All data were examined for collinearity and Schoenfeld residuals were used to

assess the proportional hazards assumption. The alpha level was set to the conventional 0.05.

3. Results

3.1. Treatment retention

A slight majority of the sample completed treatment (51.3%). The average length of stay for the full sample was 18.7 days ($SD = 10.7$); for treatment episodes ending in premature discharge, the average length of stay was 8.9 days ($SD = 7.0$). The sample had a mean score of 22.1 ($SD = 7.9$) for the PSS (Table 1). Those who completed treatment reported significantly lower levels of stress at admission ($M = 20.8$; $SD = 7.6$) than those who were discharged from treatment before 28 days ($M = 23.5$; $SD = 8.1$).

Table 2 provides results from the Cox regression model. Higher perceived stress (adjusted hazard ratio [AHR] = 1.028; 95% CI = [1.005, 1.053]; $p = 0.019$) and being of another race/ethnicity compared to being Non-Hispanic Black (AHR = 1.546; 95% CI = [1.037, 2.305]; $p = .033$) predicted premature discharge. For each one-point increase in PSS score, individuals had a 3% higher risk of prematurely discharging from treatment.

4. Discussion

We found that higher perceived stress during admission predicted shorter treatment retention. These findings may be attributable to different factors, including the stressful nature of recovery and clients' inability to use substances to cope with this stress (Maddox-Rooper et al., 2022). This study also found that individuals being of another race/ethnicity compared to being Non-Hispanic Black predicted premature discharge in this sample. These findings may stem from the lower level of treatment engagement that is identified of other racial/ethnic groups in a primarily African American treatment setting (Melnick et al., 2011) and the greater socioeconomic similarities across racial/ethnic groups in this sample compared to the socioeconomic disparities seen in other national studies examining treatment retention (Stahler et al., 2016; Stahler & Mennis, 2018).

Stress can be a response that helps individuals avoid potentially uncomfortable situations. Individuals in this sample with higher

Table 2
Cox Regression Analyses Predicting Premature Treatment Discharge.

Variable	AHR (95% CI)	*p*
Perceived Stress	1.028 (1.005, 1.053)	0.019
Age	0.994 (0.977, 1.011)	0.495
Gender (Ref: Woman)		
Man	0.971 (0.649, 1.453)	0.887
Race and Ethnicity (Ref: Non-Hispanic Black)		
Other Race and Ethnicity	1.546 (1.037, 2.305)	0.033
Education Level (Ref: Less than HS or GED)[a]		
Completed HS or GED	1.303 (0.865, 1.963)	0.205
Some college or college degree	1.213 (0.722, 2.038)	0.465
Housing Status (Ref: Unstable housing)		
Private residence	1.109 (0.750, 1.639)	0.605
Other housing status	0.866 (0.322, 2.333)	0.776
Recent Anxiety (Ref: No)		
Yes	1.083 (0.671, 1.749)	0.743
Recent Depression (Ref: No)		
Yes	1.091 (0.692, 1.720)	0.708
Primary Substance (Ref: Heroin)		
Alcohol	0.824 (0.526, 1.291)	0.398
Cocaine	1.266 (0.753, 2.114)	0.377
Other primary substance	0.963 (0.499, 1.860)	0.911
Polysubstance Use (Ref: No)		
Yes	1.291 (0.842, 1.978)	0.241

[a] AHR = Adjusted Hazard Ratio; HS = High school; GED = General equivalency degree.

perceived stress may have left treatment prematurely in response to their discomfort. Further, abstaining from substances during treatment and recovery is itself inherently stressful (Maddox-Rooper et al., 2022). Changing patterns related to substance use is also stressful as it may cause different interactions with an individual's environment after treatment discharge.

Along with the inherently stressful nature of SUD recovery, being unable to use substances to cope with stress during treatment may have a greater impact on individuals with higher perceived stress. Except for rule infractions (e.g., filtering through illicit substances), entering residential treatment is a barrier to accessing substances. As some individuals use substances to cope (Bornovalova et al., 2012; Buckner et al., 2007; Khantzian, 1985; Marshall-Berenz et al., 2011; Preston et al., 2018a; Preston et al., 2018b), a lack of other stress management techniques may prompt premature discharge among individuals that enter treatment with higher perceived stress. The absence of substances as a coping mechanism may even further increase clients' perception of distress. Given that the prematurely discharged group stayed an average of approximately nine days, stress management interventions provided by clinical staff within the first week may be particularly critical to enhancing the retention of these individuals in treatment.

Along with higher perceived stress, this study found that being of a race/ethnicity other than Non-Hispanic Black predicted premature discharge. These results contradict those of prior large national studies on treatment retention, which have found Non-Hispanic Black individuals representing a larger proportion of those with a lower socioeconomic status (based on education level, employment status, and housing status) and leaving treatment prematurely (e.g., Stahler & Mennis, 2018; Stahler et al., 2016; Ware et al., 2021). However, the present study's sample is atypical compared to those of these national studies, as in our sample there were more socioeconomic similarities than differences across racial/ethnic groups.

We performed supplemental analyses and found no statistically significant differences in education level or employment status between those who were Non-Hispanic Black and those of another race/ethnicity. However, we observed significant differences in housing status, with a smaller proportion of Non-Hispanic Black individuals ($n = 52$, 26.8%) having unstable housing compared to those of another race/ethnicity ($n = 34$, 44.2%) $p < .05$. Future national studies examining treatment retention across racial/ethnic groups with similar socioeconomic characteristics may be a benefit to the literature. Also, a prior study of an SUD treatment setting primarily serving African Americans found that White participants tended to be less engaged in treatment than their African American counterparts (Melnick et al., 2011). A similar lack of engagement in treatment may also explain lower treatment retention among individuals who were Non-Hispanic Black in this study, which gathered data from a treatment setting primarily serving African American adults.

4.1. Limitations

We used a self-report measure of stress; repeated measures during treatment and physiological measures may provide a more complete picture of the role of stress in retention (Kyriakou et al., 2019; Ligabue et al., 2020; Maddox-Rooper et al., 2022). However, the PSS at admission has clinical utility and is correlated with cortisol levels (van Eck & Nicolson, 1994). The current study was limited to a single treatment setting, making it impossible to assess programmatic variables (Miles et al., 2022). COVID-19 might also have affected both stress and treatment retention for admissions in February 2020. Although this study focused on any premature discharge reason, a future study would benefit from examining differences in stress and patient demographics across all four discharge reasons. Finally, we were unable to control for the experience of craving and withdrawal on treatment retention.

4.2. Conclusions

This study highlights the importance of assessing stress among those entering residential treatment and tracking treatment retention. Studies have shown that longer treatment retention is associated with beneficial treatment outcomes such as harm reduction related to substance use (Daigre et al., 2021; Hser et al., 2004; Hubbard et al., 2003). Because higher stress during treatment admission is a predictor of treatment retention, appropriate stress management interventions may benefit those with higher perceived stress, especially during the first week of residential treatment (Black & Amaro, 2019; Bornovalova et al., 2012). Stress management interventions, combined with substance-dependent medications for SUD and behavioral therapy, may encourage longer treatment retention (Dalton et al., 2021). Stress management is an essential factor to incorporate in all treatments and may improve treatment outcomes.

Funding

CRediT statement

All authors contributed to the creation of this research article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

References

Ali, B., Green, K. M., Daughters, S. B., & Lejuez, C. W. (2017). Distress tolerance interacts with circumstances, motivation, and readiness to predict substance abuse treatment retention. *Addictive Behaviors, 73*, 99–104. https://doi.org/10.1016/j.addbeh.2017.04.016

Alinsky, R. H., Zima, B. T., Rodean, J., Matson, P. A., Larochelle, M. R., Adger, H., … Hadland, S. E. (2020). Receipt of addiction treatment after opioid overdose among Medicaid-enrolled adolescents and young adults. *JAMA Pediatrics, 174*(3), e195183.

Ames, S. C., & Roitzsch, J. C. (2000). The impact of minor stressful life events and social support on cravings: A study of inpatients receiving treatment for substance dependence. *Addictive Behaviors, 25*(4), 539–547. https://doi.org/10.1016/s0306-4603(00)00069-1

Baker, D. E., Edmonds, K. A., Calvert, M. L., Sanders, S. M., Bridges, A. J., Rhea, M. A., & Kosloff, S. (2020). Predicting attrition in long-term residential substance use disorder treatment: A modifiable risk factors perspective. *Psychological Services, 17*(4), 472–482. https://doi.org/10.1037/ser0000333

Bergeria, C. L., Strickland, J. C., Huhn, A. S., Strain, E. C., & Dunn, K. E. (2021). A preliminary examination of the multiple dimensions of opioid craving. *Drug and Alcohol Dependence, 219*, Article 108473. https://doi.org/10.1016/j.drugalcdep.2020.108473

Black, D. S., & Amaro, H. (2019). Moment-by-Moment in Women's Recovery (MMWR): Mindfulness-based intervention effects on residential substance use disorder treatment retention in a randomized controlled trial. *Behaviour Reseach and Therapy, 120*, Article 103437. https://doi.org/10.1016/j.brat.2019.103437

Bornovalova, M. A., Gratz, K. L., Daughters, S. B., Hunt, E. D., & Lejuez, C. W. (2012). Initial RCT of a distress tolerance treatment for individuals with substance use disorders. *Drug and Alcohol Dependence, 122*(1–2), 70–76. https://doi.org/10.1016/j.drugalcdep.2011.09.012

Buckner, J. D., Keough, M. E., & Schmidt, N. B. (2007). Problematic alcohol and cannabis use among young adults: The roles of depression and discomfort and distress tolerance. *Addictive Behaviors, 32*(9), 1957–1963. https://doi.org/10.1016/j.addbeh.2006.12.019

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*(4), 385–396. https://doi.org/10.2307/2136404

Daigre, C., Rodríguez, L., Roncero, C., Palma-Álvarez, R. F., Perea-Ortueta, M., Sorribes-Puertas, M., Martínez-Luna, N., Ros-Cucurull, E., Ramos-Quiroga, J. A., & Grau-López, L. (2021). Treatment retention and abstinence of patients with substance use disorders according to addiction severity and psychiatry comorbidity: A six-month

follow-up study in an outpatient unit. *Addictive Behaviors, 117*, Article 106832. https://doi.org/10.1016/j.addbeh.2021.106832

Dalton, K., Bishop, L., & Darcy, S. (2021). Investigating interventions that lead to the highest treatment retention for emerging adults with substance use disorder: A systematic review. *Addictive Behaviors, 122*, Article 107005. https://doi.org/10.1016/j.addbeh.2021.107005

Darke, S., Campbell, G., & Popple, G. (2012). Retention, early dropout and treatment completion among therapeutic community admissions. *Drug and Alcohol Review, 31* (1), 64–71. https://doi.org/10.1111/j.1465-3362.2011.00298.x

Dunn, K. E., Huhn, A. S., Bergeria, C. L., Gipson, C. D., & Weerts, E. M. (2019). Non-opioid neurotransmitter systems that contribute to the opioid withdrawal syndrome: A review of preclinical and human evidence. *Journal of Pharmacology and Experimental Therapeutics, 371*(2), 422–452. https://doi.org/10.1124/jpet.119.258004

Hawk, K. F., Vaca, F. E., & D'Onofrio, G. (2015). Reducing fatal opioid overdose: Prevention, treatment and harm reduction strategies. *Yale Journal of Biology and Medicine, 88*(3), 235–245.

Heggeness, L. F., Lechner, W. V., & Ciesla, J. A. (2019). Coping via substance use, internal attribution bias, and their depressive interplay: Findings from a three-week daily diary study using a clinical sample. *Addictive Behaviors, 89*, 70–77. https://doi.org/10.1016/j.addbeh.2018.09.019

Hser, Y. I., Evans, E., Huang, D., & Anglin, D. M. (2004). Relationship between drug treatment services, retention, and outcomes. *Psychiatr Serv, 55*(7), 767–774. https://doi.org/10.1176/appi.ps.55.7.767

Hubbard, R. L., Craddock, S. G., & Anderson, J. (2003). Overview of 5-year followup outcomes in the drug abuse treatment outcome studies (DATOS). *Journal of Substance Abuse Treatment, 25*(3), 125–134. https://doi.org/10.1016/s0740-5472(03)00130-2

IBM Corp. (2020). SPSS Statistics, Version 27.0. Armonk, NY.

Kariisa, M., Davis, N. L., Kumar, S., Seth, P., Mattson, C. L., Chowdhury, F., & Jones, C. M. (2022). Vital signs: Drug overdose deaths, by selected sociodemographic and social determinants of health characteristics - 25 states and the District of Columbia, 2019–2020. *Morbidity and Mortality Weekly Report, 71*(29), 940–947. https://doi.org/10.15585/mmwr.mm7129e2.

Khantzian, E. J. (1985). The self-medication hypothesis of addictive disorders: Focus on heroin and cocaine dependence. *American Journal of Psychiatry, 142*(11), 1259–1264. https://doi.org/10.1176/ajp.142.11.1259

Kilaru, A. S., Xiong, A., Lowenstein, M., Meisel, Z. F., Perrone, J., Khatri, U., Mitra, N., & Delgado, M. K. (2020). Incidence of treatment for opioid use disorder following nonfatal overdose in commercially insured patients. *JAMA Network Open, 3*(5), e205852.

Kyriakou, K., Resch, B., Sagl, G., Petutschnig, A., Werner, C., Niederseer, D., Liedlgruber, M., Wilhelm, F. H., Osborne, T., & Pykett, J. (2019). Detecting moments of stress from measurements of wearable physiological sensors. *Sensors (Basel), 19* (17), 3805. https://doi.org/10.3390/s19173805

Lappan, S. N., Brown, A. W., & Hendricks, P. S. (2020). Dropout rates of in-person psychosocial substance use disorder treatments: A systematic review and meta-analysis. *Addiction, 115*(2), 201–217. https://doi.org/10.1111/add.14793

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York, NY: Springer.

Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing Research, 6*(4), 121–127. https://doi.org/10.1016/j.anr.2012.08.004

Ligabue, K. P., Schuch, J. B., Scherer, J. N., Ornell, F., Roglio, V. S., Assunção, V., Rebelatto, F. P., Hidalgo, M. P., Pechansky, F., Kessler, F., & von Diemen, L. (2020). Increased cortisol levels are associated with low treatment retention in crack cocaine users. *Addictive Behaviors, 103*, Article 106260. https://doi.org/10.1016/j.addbeh.2019.106260

MacLean, R. R., Armstrong, J. L., & Sofuoglu, M. (2019). Stress and opioid use disorder: A systematic review. *Addictive Behaviors, 98*, Article 106010. https://doi.org/10.1016/j.addbeh.2019.05.034

Maddox-Rooper, T. R., Sklioutouskaya-Lopez, K., Sturgill, T., Fresch, C., Clements, C. W., II, Lamichhane, R., Egleton, R., & Davis, T. D. (2022). Intake assessments of salivary cortisol, survey responses, and adverse childhood experiences are associated with recovery success in an abstinence-based program. *Alcoholism: Clinical & Experimental Research, 46*(10), 1865–1874. https://doi.org/10.1111/acer.14913

Marshall-Berenz, E. C., Vujanovic, A. A., & Macpherson, L. (2011). Impulsivity and alcohol use coping motives in a trauma-exposed sample: The mediating role of distress tolerance. *Personality and Individual Differences, 50*(5), 588–592. https://doi.org/10.1016/j.paid.2010.11.033

McHugh, R. K., Sugarman, D. E., Meyer, L., Fitzmaurice, G. M., & Greenfield, S. F. (2020). The relationship between perceived stress and depression in substance use disorder treatment. *Drug and Alcohol Dependence, 207*, Article 107819. https://doi.org/10.1016/j.drugalcdep.2019.107819

McLellan, A. T., Kushner, H., Metzger, D., Peters, R., Smith, I., Grissom, G., Pettinati, H., & Argeriou, M. (1992). The fifth edition of the addiction severity index. *Journal of Substance Abuse Treatment, 9*(3), 199-213. https://doi.org/10.1016/0740-5472(92)90062-s.

Melnick, G., Duncan, A., Thompson, A., Wexler, H. K., Chaple, M., & Cleland, C. M. (2011). Racial disparities in substance abuse treatment and the ecological fallacy. *Journal of Ethnicity in Substance Abuse, 10*(3), 226–245. https://doi.org/10.1080/15332640.2011.600201

Miles, J., Mericle, A., Ritter, G., & Reif, S. (2022). Association of facility characteristics and substance use disorder outcomes at discharge from residential treatment. *Journal of Substance Abuse Treatment, 136*, Article 108664. https://doi.org/10.1016/j.jsat.2021.108664

Mutter, R., & Ali, M. M. (2019). Factors associated with completion of alcohol detoxification in residential settings. *Journal of Substance Abuse Treatment, 98*, 53–58. https://doi.org/10.1016/j.jsat.2018.12.009

Mutter, R., Ali, M. M., Smith, K., & Strashny, A. (2015). Factors associated with substance use treatment completion in residential facilities. *Drug and Alcohol Dependence, 154*, 291–295. https://doi.org/10.1016/j.drugalcdep.2015.07.004

O'Reilly, H., Hagerty, A., O'Donnell, S., Farrell, A., Hartnett, D., Murphy, E., & Farren, C. (2019). Alcohol use disorder and comorbid depression: A randomized controlled trial investigating the effectiveness of supportive text messages in aiding recovery. *Alcohol and Alcoholism, 54*(5), 551–558. https://doi.org/10.1093/alcalc/agz060

Pasareanu, A. R., Vederhus, J. K., Opsal, A., Kristensen, Ø., & Clausen, T. (2017). Mental distress following inpatient substance use treatment, modified by substance use; comparing voluntary and compulsory admissions. *BMC Health Services Research, 17* (1), 5. https://doi.org/10.1186/s12913-016-1936-y

Phillips, A. C. (2013). Perceived stress. In M. D. Gellman, & J. R. Turner (Eds.), *Encyclopedia of Behavioral Medicine* (pp. 1453–1454). Springer. https://doi.org/10.1007/978-1-4419-1005-9_479.

Pollini, R. A., McCall, L., Mehta, S. H., Vlahov, D., & Strathdee, S. A. (2006). Non-fatal overdose and subsequent drug treatment among injection drug users. *Drug and Alcohol Dependence, 83*(2), 104–110. https://doi.org/10.1016/j.drugalcdep.2005.10.015

Preston, K. L., Kowalczyk, W. J., Phillips, K. A., Jobes, M. L., Vahabzadeh, M., Lin, J. L., … Epstein, D. H. (2018a). Exacerbated craving in the presence of stress and drug cues in drug-dependent patients. *Neuropsychopharmacology, 43*(4), 859–867. https://doi.org/10.1038/npp.2017.275

Preston, K. L., Schroeder, J. R., Kowalczyk, W. J., Phillips, K. A., Jobes, M. L., Dwyer, M., … Epstein, D. H. (2018b). End-of-day reports of daily hassles and stress in men and women with opioid-use disorder: Relationship to momentary reports of opioid and cocaine use and stress. *Drug and Alcohol Dependence, 193*, 21–28. https://doi.org/10.1016/j.drugalcdep.2018.08.023

Rivera, D., Dueker, D., & Amaro, H. (2021). Examination of referral source and retention among women in residential substance use disorder treatment: A prospective follow-up study. *Substance Abuse Treatment, Prevention, and Policy, 16*(1), 21. https://doi.org/10.1186/s13011-021-00357-y

Ruisoto, P., & Contador, I. (2019). The role of stress in drug addiction. *An integrative review. Physiology & Behavior, 202*, 62–68. https://doi.org/10.1016/j.physbeh.2019.01.022

Saloner, B., & Lê Cook, B. (2013). Blacks and Hispanics are less likely than whites to complete addiction treatment, largely due to socioeconomic factors. *Health Affairs, 32*(1), 135–145. https://doi.org/10.1377/hlthaff.2011.0983

Schuman-Olivier, Z., Claire Greene, M., Bergman, B. G., & Kelly, J. F. (2014a). Is residential treatment effective for opioid use disorders? A longitudinal comparison of treatment outcomes among opioid dependent, opioid misusing, and non-opioid using emerging adults with substance use disorder. *Drug and Alcohol Dependence, 144*, 178–185. https://doi.org/10.1016/j.drugalcdep.2014.09.009

Schuman-Olivier, Z., Weiss, R. D., Hoeppner, B. B., Borodovsky, J., & Albanese, M. J. (2014b). Emerging adult age status predicts poor buprenorphine treatment retention. *Journal of Substance Abuse and Treatment, 47*(3), 202–212. https://doi.org/10.1016/j.jsat.2014.04.006

Sinha, R. (2008). Chronic stress, drug use, and vulnerability to addiction. *Annals of the New York Academy of Sciences, 1141*, 105–130. https://doi.org/10.1196/annals.1441.030

Stahler, G. J., & Mennis, J. (2018). Treatment outcome disparities for opioid users: Are there racial and ethnic differences in treatment completion across large US metropolitan areas? *Drug and Alcohol Dependence, 190*, 170–178. https://doi.org/10.1016/j.drugalcdep.2018.06.006

Stahler, G. J., Mennis, J., & DuCette, J. P. (2016). Residential and outpatient treatment completion for substance use disorders in the U.S.: Moderation analysis by demographics and drug of choice. *Addictive Behaviors, 58*, 129–135. https://doi.org/10.1016/j.addbeh.2016.02.030

Substance Abuse and Mental Health Services Administration. (2016). *Facing addiction in America: The Surgeon General's report on alcohol, drugs, and health: Chapter 4, Early intervention, treatment, and management of substance use disorders.* National Library of Medicine.

Substance Abuse and Mental Health Services Administration. (2021). *Key substance use and mental health indicators in the United States: Results from the 2020 National survey on drug use and health (HHS Publication No. PEP21-07-01-003, NSDUH Series H-56).* https://www.samhsa.gov/data/.

Summers, P. J., Hellman, J. L., MacLean, M. R., Rees, V. W., & Wilkes, M. S. (2018). Negative experiences of pain and withdrawal create barriers to abscess care for people who inject heroin. A mixed methods analysis. *Drug and Alcohol Dependence, 190*, 200–208. https://doi.org/10.1016/j.drugalcdep.2018.06.010

Tang, K. N. S., & Chan, C. S. (2017). Life satisfaction and perceived stress among young offenders in a residential therapeutic community: Latent change score analysis. *Journal of Adolescence, 57*(1), 42–53. https://doi.org/10.1016/j.adolescence.2017.03.005

Tull, M. T., Gratz, K. L., Coffey, S. F., Weiss, N. H., & McDermott, M. J. (2013). Examining the interactive effect of posttraumatic stress disorder, distress tolerance, and gender on residential substance use disorder treatment retention. *Psychology of Addictive Behaviors, 27*(3), 763–773. https://doi.org/10.1037/a0029911

Van Eck, M. M., & Nicolson, N. A. (1994). Perceived stress and salivary cortisol in daily life. *Annals of Behavioral Medicine, 16*(3), 221–227. https://doi.org/10.1093/abm/16.3.221

Wallen, J. (1992). A comparison of male and female clients in substance abuse treatment. *Journal of Substance Abuse and Treat, 9*(3), 243–248. https://doi.org/10.1016/0740-5472(92)90067-x

Ware, O. D., Ellis, J. D., Dunn, K. E., Hobelmann, J. G., Finan, P., & Huhn, A. S. (2022). The association of chronic pain and opioid withdrawal in men and women with opioid use disorder. *Drug and Alcohol Dependence, 240*, Article 109631. https://doi.org/10.1016/j.drugalcdep.2022.109631

Ware, O. D., Manuel, J. I., & Huhn, A. S. (2021). Adults with opioid and methamphetamine co-use have lower odds of completing short-term residential treatment than other opioid co-use groups: A retrospective health services study. *Frontiers in Psychiatry, 12*, Article 784229. https://doi.org/10.3389/fpsyt.2021.784229

Wolitzky-Taylor, K., Drazdowski, T. K., Niles, A., Roy-Byrne, P., Ries, R., Rawson, R., & Craske, M. G. (2018). Change in anxiety sensitivity and substance use coping motives as putative mediators of treatment efficacy among substance users. *Behaviour Research and Therapy, 107*, 34–41. https://doi.org/10.1016/j.brat.2018.05.010

Zemore, S. E., Ware, O. D., Gilbert, P. A., & Pinedo, M. (2021). Barriers to retention in substance use treatment: Validation of a new, theory-based scale. *Journal of Substance Abuse Treatment, 131*, Article 108422. https://doi.org/10.1016/j.jsat.2021.108422

Zhang, Z., Friedmann, P. D., & Gerstein, D. R. (2003). Does retention matter? Treatment duration and improvement in drug use. *Addiction, 98*(5), 673–684. https://doi.org/10.1046/j.1360-0443.2003.00354.x