

Understanding Pathways Between PTSD, Homelessness, and Substance Use Among Adolescents

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Youth experiencing homelessness have been shown to experience high levels of both trauma and substance use. However, prior work has yet to consider how substance use, posttraumatic stress disorder (PTSD) symptoms, and homelessness are temporally, or reciprocally, associated over time. The current study uses symptom-driven and experience-driven models to examine the reciprocal relationships between substance use, PTSD symptoms, and homelessness among a large sample of adolescents receiving substance use treatment in the United States. Adolescents ($n = 20,069$; $M_{\text{age}} = 15.6$; 74% male) completed baseline, 3-, 6-, and 12-month assessments. Autoregressive latent trajectory with structured residual (ALT-SR) models were used to examine within- and between-person relationships. We found continued support for prior work at the between-person level of analysis. At the within-person level, during the treatment phase, PTSD emerged as a key mechanism predicting both return to use and increased days of homelessness posttreatment. Further, greater substance use at treatment completion was associated with greater PTSD symptoms and homelessness, prospectively. The current study extends the previous work to consider individual level processes in conjunction with overarching event level predictors of homelessness. We found that PTSD symptomology is a driving factor that influences, both directly and indirectly, experiences of homelessness posttreatment. Interventions may wish to incorporate trauma informed approaches for youth entering treatment as this may mitigate long-term experiences of homelessness and return to substance use.

Keywords: addiction treatment, substance use, posttraumatic stress disorder, homelessness, adolescents

Current estimates indicate that, in the United States, approximately 184,000 (0.7%) adolescents aged 14 to 17 in the United States received substance use treatment in the past year (Substance Abuse and Mental Health Services Administration, 2018). A number of studies have reported lifetime incidence of posttraumatic stress disorder (PTSD) among (mostly adult) treatment samples to be between 26% and 52% (Driessen et al., 2008; Reynolds, Hinchliffe, Asamoah, & Kouimtsidis, 2011; Schäfer et al., 2010).

Of great concern are subpopulations of adolescents who have experienced, or are at risk of experiencing, homelessness (Davies & Allen, 2017). Youth who experience homelessness are a highly vulnerable population with high rates of abuse, trauma, violence, and substance use (Davies & Allen, 2017).

Previous developmental research examining intersections between homelessness, posttraumatic stress and substance use has involved samples of youth drawn from drop-in centers or shelters (Milburn et al., 2009; Milburn et al., 2019; Tyler, Johnson, & Brownridge, 2008; Whitbeck, Hoyt, & Yoder, 1999). However, there is a dearth of evidence documenting risks for experiencing homelessness among adolescents receiving substance use treatment. Further, among the few longitudinal studies involving run-away and homeless youth, few have examined the complex, reciprocal relationships between PTSD symptoms, substance use, and homelessness episodes over time. Therefore, the current study seeks to address these gaps by examining bidirectional relationships between PTSD symptoms, substance use, and episodes of homelessness over time among adolescents receiving substance use treatment.

Theoretical and Empirical Considerations

Many adolescents participating in substance use treatment, also have histories of homelessness (Folsom et al., 2005) and traumatic stress (Berry & Sellman, 2001; Cottler, Compton, Mager, Spitznagel, & Janca, 1992) and, unfortunately, continue to experience these maladies after exiting substance use treat-

This article was published Online First July 25, 2019.

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The data reported in this article were obtained from publicly available data via the Global Appraisal of Individual Needs website (gaincc.org). A bibliography of journal articles, working papers, conference presentations, and dissertations using Global Appraisal of Individual Needs data is available at <http://gaincc.org/publications/>. Data from this article have not been published or presented elsewhere.

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ment. There are two theoretical models that may help aid our understanding of how trauma symptomology may influence experiences of homelessness and eventual return to substance use following treatment discharge: symptom-driven models and experience-driven models.

Symptom-driven models posit that psychological symptoms (e.g., symptoms of PTSD, depression, or other psychological disorder) precede long-term cascades of negative behavioral health outcomes (Agoston & Rudolph, 2013; Davis et al., 2018; Lewinsohn, Steinmetz, Larson, & Franklin, 1981). Originally used as a theoretical orientation for depression, symptom-driven models have since been used to understand how symptomology of other disorders can put individuals at greater risk of maladaptive interpersonal outcomes. Evidence of symptom-driven models is abundant. Prior research has shown that, among homeless individuals, severity of PTSD symptoms (e.g., no symptom improvement following intervention) predicted increased substance use following treatment discharge (Burns, Lehman, Milby, Wallace, & Schumacher, 2010). Others have noted that the onset of PTSD precedes the onset of homelessness (Hodgson, Shelton, van den Bree, & Los, 2013; North & Smith, 1992). Further, in a small, cross-sectional study, PTSD symptoms were directly related to increased alcohol use among a sample of homeless mothers (Yeater, Austin, Green, & Smith, 2010). Studies of homeless youth have also found that for every additional experience of victimization, the odds of meeting criteria for a substance use disorder nearly double (Bender, Brown, Thompson, Ferguson, & Langenderfer, 2015), and meeting criteria for PTSD was associated with increased odds of having a substance use disorder (Bender, Ferguson, Thompson, Komlo, & Pollio, 2010). Finally, among an analog population (military veterans), trauma symptomology and alcohol use were associated with time to homelessness for women (Benda, 2006). Thus, PTSD symptomology may serve as a catalyst for a larger pattern of reciprocal problems following treatment discharge. As such, using a symptom-driven perspective can aid in determining if PTSD symptomology precedes experiences of homelessness or increases in substance use following adolescents' discharge from substance use treatment.

We next set out to explore how experiences of homelessness may drive both short and long-term psychopathology and maladaptive behaviors. We conceptualize this pathway as an experience-driven risk model. This framework is borrowed from long-standing conceptual and empirical work based on interpersonal risk models (Agoston & Rudolph, 2013). Interpersonal risk models were born out of the bullying (peer)-victimization literature and propose that experiencing bullying victimization initiates a cascade of problems such as increased psychopathology and problematic substance use (Davis et al., 2018). Prior research involving homeless youth lends support for experience-driven risk models. For example, cross-sectional work has shown that homeless youth who are more transient likely have higher rates of PTSD and alcohol dependence (Bender et al., 2010). Others have found that, once youth become homeless, there is an increase in psychological (e.g., PTSD, depression) and substance use diagnoses (Martijn & Sharpe, 2006). In the current study, traumatic events experienced while currently homeless may increase trauma symptomology and substance use, either through social learning mechanisms while on the street and/or as a means to cope with trauma symptoms.

Disaggregating Between- and Within-Person Effects

Despite previous longitudinal work investigating the associations between substance use, PTSD symptoms, and homelessness (either together or separately), many of these studies are limited in their scope and ability to accurately interpret estimated paths. Even among the few studies that have incorporated directionality in their models (Tyler & Schmitz, 2018; Whitbeck, Hoyt, & Bao, 2000), many have not assessed bidirectionality (e.g., transactional processes) or appropriately disaggregated variance into their two components: between-person and within-person. Typically, when researchers attempt to understand reciprocal relationships, they use autoregressive cross-lagged models. These models yield estimates that are a combination of both between-person and within-person variance which are difficult (if not impossible) to interpret, because they are a combination of between-and within-person variance (Berry & Willoughby, 2017). This can have profound effects on the interpretability of the bidirectional (or unidirectional) associations between two or more variables. We use recent advances in modeling longitudinal relationships that allow for the disaggregation of both within- and between-person effects. Recent models for longitudinal data, such as the autoregressive latent trajectory model with structured residuals (ALT-SR) introduced by Curran, Howard, Bainter, Lane, and McGinley (2014), improve our ability to understand cross-lagged or reciprocal relationships over time (Berry & Willoughby, 2017; Davis et al., 2018; Merrin, Davis, Berry, D'Amico, & Dumas, 2016). Specifically, the ALT-SR model allows one to simultaneously consider between-person relations among more systematic—or trait-like—aspects of substance use and, say, homelessness (e.g., mean levels, growth rates), while simultaneously modeling reciprocal relations between these variables as they manifest within individuals over time. This modeling approach invites two advantages. First, it anchors the reciprocal processes at an arguably more meaningful and relevant level of analysis—within-person. Second, the internal validity of the reciprocal effects is strengthened as each individual serves as his or her own control (and therefore, all time-invariant confounds are controlled).

Summary and Hypotheses

While prior studies have attempted to ascertain mental health correlates of homelessness, many of the studies are cross-sectional in nature and, thus, cannot determine temporal order. Thus, while there has been some longitudinal work both predicting homelessness (e.g., among a non-homeless sample) and predicting substance use and psychopathology among homeless samples, no longitudinal study has attempted to discern the temporal order of events related to PTSD symptomology, substance use, and experiences of homelessness. Further, most prior work has only considered trauma related events and not symptomology (e.g., PTSD) that may be a unique factor predicting risk of homelessness and future problems (e.g., increased substance use). In the current study, we test symptom-driven and experience drive risk models. Specifically, we sought to examine the overall between-person associations among our variables of interest including the initial levels (i.e., intercepts) and change (i.e., slopes). Thus, we hypothesize (Hypothesis 1) small to moderate between-person associations among PTSD symptoms, substance use, and homelessness episodes.

Our hypotheses for within-person associations will examine temporal associations from two theoretical perspectives: symptom-driven and experience-driven risk model. Given that we only have two time points during the treatment phase (baseline to 3-month follow-up) our hypotheses are directed at the posttreatment phase (3-, 6-, and 12-month follow up). We will, however, report any emergent findings during the treatment phase as these can inform clinical practice and theory. Hypothesis 2 reflects a symptom-driven model. After controlling for lifetime experiences of victimization, we sought to understand whether symptoms of PTSD are driving pathways to increased experiences of homelessness and return to substance use following completion of substance use disorder treatment. Hypothesis 3 reflects an experience-driven risk model. Here we seek to understand if experiences of homelessness precede increased PTSD symptomology and subsequent return to substance use following treatment discharge. Based on prior literature we hypothesize that experiences of homelessness will predict increased PTSD symptomology as well as increased substance use.

Method

Participants and Procedure

Participants were 20,069 adolescents aged 15.6 years on average ($SD = 1.21$), receiving substance use treatment in treatment settings throughout the United States that utilized the Global Appraisal of Individual Needs (GAIN) set of assessments. Data were collected with the informed consent of individuals receiving treatment as part of general clinical practice or in the context of a research study at each site, which were approved by each site's respective Institutional Review Board. The majority of participants were male (74%; $n = 14,811$) and the sample was diverse with 36.1% identifying as White ($n = 7,252$), 29.9% Hispanic ($n = 6,005$), 15.4% African American ($n = 3,086$), 15.4% multiple race/ethnicity ($n = 3,084$), and 3.2% as other race/ethnicity ($n = 634$). In terms of substance use, 52.2% ($n = 10,480$) had lifetime substance dependence with 77.9% ($n = 15,647$) having any past year substance use diagnosis. On average, at intake, participants reported using cannabis on 22.5 ($SD = 28.8$) days, alcohol on 5.4 ($SD = 11.6$) days, and heavy drinking on 3.27 ($SD = 8.38$) days out of the past 90 days. Further, nearly 9% of the sample ($n = 1,779$) reported experiencing homelessness at some time between intake and their 12 month follow-up. Further, youth reported, on average, 2.12 ($SD = 3.34$) PTSD symptoms at baseline. See Tables 1 and 2 for more details on participant characteristics.

Data were obtained from 137 sites associated with the Center for Substance Abuse Treatment Substance Abuse and Mental Health Services Administration-funded programs that provide community outpatient substance use treatment and whose records feed a national data set managed by the GAIN Coordinating Center (Dennis, Titus, White, Unsicker, & Hodgkins, 2003). The GAIN originated as a collaborative effort between clinicians, researchers, and policymakers to create a standardized assessment tool for individuals receiving substance use and mental health services. The GAIN provides tools for initial screenings, brief interventions and referrals, clinical assessments, placement recommendations, and program/evaluation services. The GAIN assessment tool (GAIN-I) is a comprehensive, structured interview with over 100 scales situated within eight main sections including background,

Table 1
Baseline Characteristics

Characteristic	<i>M (SD) or n (%) (N = 20,069)</i>
Demographics	
Age, in years	15.6 (1.21)
Female, <i>n (%)</i>	5,258 (26.2%)
Race/Ethnicity, <i>n (%)</i>	
White	7,252 (36.1%)
African American	3,086 (15.4%)
Hispanic	6,005 (29.9%)
Multiple race/ethnicity	3,084 (15.4%)
Other	634 (3.2%)
Psychiatric disorders	
Posttraumatic stress disorder	2.12 (3.34)
General Victimization Scale	2.98 (3.09)
Substance use	
Substance Frequency Scale	11.6 (13.6)
Prior treatment episodes, <i>n (%)</i>	6,319 (31.5%)
Homelessness	
Days of homelessness	3.86 (6.55)

Note. Data are presented as *M (SD)* except where otherwise indicated.

substance use, physical health, risk behaviors, mental health, environment, legal, and vocational. Each site that administered the GAIN went through extensive training (2–3 months for certification) that included practice sessions, observations, and supervised administration. Typically, the GAIN takes between 90 and 120 min per patient to complete. All assessments are completed on a computer adaptive system that includes skip patterns and prompts when discrepancies occur to ensure accurate data collection.

Youth entering treatment came from a variety of referral sources, including self-referral (1%), family or friends (7%), criminal justice system (23%), school or work (4%), social services agency (3%), or a behavioral health/state treatment facility (4%). Not all participants had data on referral source. At treatment entry, each person completed the initial GAIN assessment (GAIN-I). After the initial assessment, participants were referred to receive treatment (with treatment type varying by site) and completed GAIN follow-up assessments at 3, 6, 9, and 12 months. All participants were given the same GAIN follow-up assessments which were completed with the assistance of GAIN trained staff.

In general, adolescents received a variety of interventions including Adolescent-Community Reinforcement Approach ($n = 7,461$, 37.1%), motivational enhancement therapy/cognitive-behavioral therapy ($n = 7,213$, 35.9%), other evidence based treatments (such as cognitive-behavioral therapy or motivational interviewing; $n = 1,537$, 7.6%), multidimensional family therapy ($n = 392$, 2.0%), specific manualized programs (e.g., site specific programming; $n = 548$, 2.7%), seven challenges ($n = 220$, 1.1%), and what would be considered "treatment as usual" (e.g., group therapy, 12-step facilitation; $n = 1,970$, 9.8%). Finally, the majority of participants entered treatment as early intervention, outpatient, or intensive outpatient (88.2%), residential facility (7.7%), or posttreatment continuing care (4.0%).

Measures

Demographic control variables and lifetime victimization. Gender was coded with female as the reference group. Race/ethnicity was dichotomized into two separate categories: nonwhite

Table 2
Correlations Among Variables of Interest at Each Time Point

Variable (follow-up period)	1	2	3	4	5	6	7	8	9	10	11	12
1. Substance use (baseline)	1											
2. Substance use (3 months)	.315	1										
3. Substance use (6 months)	.250	.507	1									
4. Substance use (12 months)	.217	.385	.472	1								
5. PTSD (baseline)	.181	.066	.080	.060	1							
6. PTSD (3 months)	.111	.102	.073	.068	.370	1						
7. PTSD (6 months)	.079	.106	.135	.063	.306	.518	1					
8. PTSD (12 months)	.070	.057	.097	.128	.262	.397	.464	1				
9. Homeless (baseline)	.097	.01	.018	.01	.093	.102	.079	.076	1			
10. Homeless (3 months)	.023	.088	.032	.029	.051	.091	.092	.066	.269	1		
11. Homeless (6 months)	.032	.055	.123	.036	.047	.102	.113	.123	.157	.312	1	
12. Homeless (12 months)	.045	.052	.068	.141	.073	.119	.122	.163	.115	.145	.206	1
<i>M</i> (<i>SD</i>)	11.57 (13.6)	6.05 (10.4)	6.11 (10.9)	7.06 (12.3)	2.12 (3.34)	.67 (2.01)	.51 (1.77)	.46 (1.67)	.86 (6.54)	.75 (6.14)	.75 (6.42)	.92 (7.24)

Note. PTSD = posttraumatic stress disorder.

and white, with nonwhite participants as the reference group. Number of prior treatment episodes (count), age (continuous), and ever been homeless (yes as reference) were all entered as covariates. Lifetime experience of trauma was measured using the General Victimization Scale (GVS). The GVS is a combination of early life traumatic experiences (e.g., physical abuse, sexual abuse, emotional abuse), exposure to direct victimization (e.g., being beat up, attacked by a knife or weapon), and trauma related characteristics (e.g., known perpetrator, happened multiple times). The GVS has good internal consistency ($\alpha = .89$).

Substance use. Substance use was assessed using the GAIN Substance Frequency Scale ($\alpha = .82$) which is the average proportion of past 90-day alcohol, heavy alcohol, cannabis, illicit drug, and problems associated with substance use. Values on the substance frequency scale are expressed as an index (from 0 to 1) and then multiplied by 100, with higher scores on this scale representing increasing frequency of substance using days and days causing problems (Dennis et al., 2003). The substance frequency scale has been validated with adolescent samples ($\alpha = .79$).

PTSD symptomology. The GAIN traumatic stress scale is a count of 13 items representing past 90-day traumatic stress symptoms that correspond to *Diagnostic and Statistical Manual of Mental Disorders-IV* PTSD symptomology. The items were chosen based on item response theory of the Mississippi Scale for Civilian PTSD (Vreven, Gudanowski, King, & King, 1995), and has shown good reliability in adolescent samples (0.92; Dennis, Chan, & Funk, 2006). Example items include “When something reminds you of the past, you become very distressed and upset,” “You were frightened by your urges,” and “You had a hard time expressing your feelings, even to the people you care about.” Participants responded with a “yes” or “no” to each of the items. Higher scores represent endorsing more symptoms of PTSD.

Homelessness. We assessed participant’s experiences of homelessness by using a single item indicator. Each participant was asked, “How many days, in the past 90, have you been homeless?” in which participants indicate a value from 0 (*no days homeless*) to 90 (*everyday homeless*). Thus, higher scores indicate more days of homelessness at each time point.

Analytic Plan

To address our hypotheses regarding the temporal associations between PTSD symptomology, substance use, and homelessness we fit a taxonomy of ALT-SR models (Curran et al., 2014). One advantage of the ALT-SR over traditional autoregressive cross-lagged models is that we are able to capture variance that does not change (intercept), variance that changes over the course of the study (slope), and the remaining residual variance captured by the residual errors representing the within-person cross-lagged associations. We specified the respective between-person trajectories as bilinear spline functions. Bilinear spline models are useful when data can be separated into discrete phases and when simple growth models cannot fit the functional form of the data. Thus, each discrete phase is a simple growth model (e.g., linear or quadratic) and the segments that connect the phases of growth are knot or transition points. In the current study we used bilinear spline models to explain change during the treatment phase (baseline to 3-month follow-up) as well as differential change during the post treatment phase (3-month follow-up to 12-month follow-up) with the intercept centered at the pretreatment assessment. All models tested for the presence of a quadratic effect during the posttreatment phase using changes in model fit ($-2 \log$ likelihood [$-2LL$] ratio test). When assessing the functional form of each variable, independently, we found a bilinear spline model did not fit the data better than a simple linear latent growth model for homelessness ($\Delta\chi^2 - 2LL = 43.5$, $\Delta df = 1$, $p < .001$). Both substance use and PTSD symptomology growth models fit best using bilinear spline models. Results of our model building process suggested that random intercepts, random linear treatment phase slopes, and fixed linear posttreatment slopes fit the data best. The latent intercepts represent the estimated population mean level and (residual) between-person variance of the given variable (i.e., baseline). The mean of the latent slope factors (both treatment and posttreatment slopes) represent the between-person variance of the change or growth of the given variable. Thus, our between person effects are captured by correlating our random latent growth factors (represented by $\phi_{standardized}$). Doing this allows our remaining within-person variance to be “pushed” into the residual autoregressive and cross-lagged portions of the model. Here, we create latent variables from the residual (e.g., error) variance from our

observed variables. These newly created latent variables are used as predictors and outcomes (e.g., each variable is a predictor and outcome in a cross-lagged model) in our within-person portion of the model.

Our taxonomy of models first established basic within-person autoregressive associations among our variables of interest (Model 1). Second, we freed the within-person cross-lagged associations between substance use, PTSD symptomology, and homelessness (Model 2). Because we are interested in associations between our variables of interest after youth complete treatment, we also estimated our within-person cross-lagged effects as two discrete phases (e.g., treatment phase and posttreatment phase). We used model constraint tests to determine if cross-lagged effects, autoregressive parameters, and within-time correlations could be constrained to be equal over time. Results of our model building process revealed improved model fit when autoregressive components of both PTSD and substance use were allowed to be freely estimated between baseline and the initial 3-month follow-up and constrained to be equal during the posttreatment phase. Within-time correlations were allowed to be freely estimated at baseline and constrained to be equal over time. Further, we found our model fit better when cross-lagged estimates were allowed to be freely estimated during the posttreatment phase (vs. constrained to be equal over time; $\Delta\chi^2 - 2LL = 20.7$, $\Delta df = 6$, $p = .02$). We used standard fit statistics to assess improvement in model specification. We used comparative fit index of .95 or greater, root mean square error of approximation of .05 or less, and standardized root mean square residual of less than .08 to indicate excellent model fit.

The GAIN data maintain an unbalanced study design. That is, some individuals have missing data simply due to the amount of time elapsed between baseline and study design (e.g., typical attrition). The majority of our missing data can be explained by censoring, or individuals who did not have an opportunity to provide data. Of the participants who could have provided data, approximately 16% and 23% of the participants showed a missing-data pattern consistent with attrition between 3 and 6 or 6 and 12 months after the start of treatment, respectively. In our missing data analysis we found, among our covariates, male, $\chi^2 = 20.4(1)$, $p < .01$, those youth who identified as racial/ethnic minority, $\chi^2 = 24.8(1)$, $p < .01$, and those who had a lifetime experience of homelessness, $\chi^2 = 8.45(1)$, $p < .01$, had more missing data. Prior substance use treatment, $\chi^2 = 1.24(1)$, $p < .27$, and lifetime victimization scores, $t = 0.32(20,057)$, $p = 0.74$, were not associated with missingness. For individuals who were able to provide data we utilized full-information maximum likelihood estimator (Mplus Version 8; Muthén & Muthén, 1998–2017), treating all observed predictors as single-item latent variables. As such, each individual contributes whatever the data they have to the likelihood function (i.e., both X and Y variables). If we assume our data are missing at random (assumption of full information maximum likelihood) our estimates would be considered unbiased (Enders, 2011). Given that prior values on X and Y variables are often reasonable predictors of missingness in longitudinal data, this lends support to the plausibility of this assumption. To adjust for nonnormality all standard errors were bootstrapped (iterations = 10,000).

Results

Below we report unstandardized estimates (b) as well as standardized estimates (β ; which are not found in the figures or tables). Between-person correlations are represented by $\phi_{standardized}$.

Overall Mean Trajectories

In our unconditional models, substance use ($\mu = -5.25$, $SE = 0.09$, $p < .01$) and PTSD symptomology ($\mu = -1.45$, $SE = 0.03$, $p < .01$) showed steep declines from baseline to 3 months (treatment phase linear growth). Growth following the treatment phase (shift parameter) slightly increased for substance use ($\mu = 0.22$, $SE = 0.04$, $p < .01$); however, PTSD symptomology ($\mu = -0.08$, $SE = 0.01$, $p < .01$) showed slight decreases through 12-month follow up during the posttreatment phase. Homelessness did not require a bilinear spline model, with participants showing small, and nonsignificant, increases in days of homelessness throughout the study period ($\mu = 0.03$, $SE = 0.01$, $p = .40$).

Hypothesis 1

Between-person associations. The intercept and slope factors indicated moderate to strong associations for between-person substance use, PTSD symptoms, and days of homelessness. Between-persons, an individual who reported higher initial levels of substance use also reported more PTSD symptoms ($\phi_{standardized} = 0.36$) than those who engaged in less substance use at treatment intake. Thus, a standard deviation increase in substance use at treatment entry is associated with a 1.20-symptom increase in PTSD. Interestingly, we did not find a significant association between initial levels of homelessness with substance use ($\phi_{standardized} = 0.09$) or PTSD symptoms ($\phi_{standardized} = 0.03$). In terms of change (e.g., slope to slope correlations) during treatment, we found individuals who reported change in substance use also reported positive change trajectories in PTSD symptomology ($\phi_{standardized} = 0.29$). This correlation can be interpreted as such: a standard deviation increase in changes in substance use during treatment is associated with a 0.70 increase in PTSD symptom change. That is, given both slopes are negative during treatment, when youth report increases in substance use the rate of change in PTSD symptomology decreases more slowly. We did not find that changes in PTSD ($\phi_{standardized} = 0.03$) or substance use ($\phi_{standardized} = 0.05$) were associated with changes in homelessness during the treatment phase.

Within-person cross-lagged associations. The final within-person cross-lagged portion of our models are presented in Figure 1. All significant pathways are represented in Figure 1, which demonstrates the lagged effects of each variable over time. All effects are presented in Table 3.

Hypothesis 2: Symptom-Driven Model

We sought to examine the presence of a symptom-driven model, where, after controlling for lifetime victimization, long-term problems (e.g., continued substance use and days of homelessness) will be driven by PTSD symptomology. Our final model evidenced excellent model fit (comparative fit index = 0.96, Tucker–Lewis index = 0.91, root mean square error of approximation = 0.03, standardized root mean square residual = 0.02). We found partial

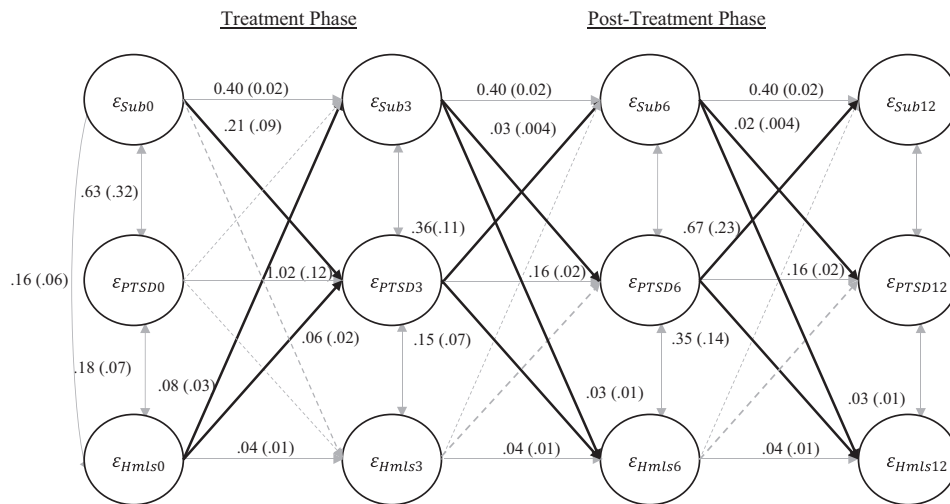


Figure 1. Autoregressive latent trajectory with structured residual final model. Bold lines indicate a significant path; gray dash lines indicate a nonsignificant path. All estimates can be found in Table 3. sub = substance use; PTSD = posttraumatic stress disorder; Hmls = days of homelessness.

support for our hypothesis of a symptom-driven model (see Figure 1). That is, during the posttreatment phase, when tracing pathways starting from PTSD (from Time 2), we found that reporting higher PTSD symptomology than one's typical average was directly associated with reporting more days of homelessness than one's typical average at the next time point ($b = 0.15$, 95% confidence interval [CI: 0.02, 0.28]; $\beta = 0.04$). Further, we can see that youth who reported higher PTSD symptomology than their own average at 3 months reported higher frequency of substance use at 6 months ($b = 0.36$, 95% CI [0.15, 0.57]; $\beta = 0.09$), and this increased substance use was associated with experiencing more days of homelessness at 12 months ($b = 0.03$, 95% CI [0.01, 0.05]; $\beta = 0.06$).

Alternatively, we also found evidence of a cascade of negative problems stemming from substance use. Specifically, those who reported a higher prevalence of substance using days than one's typical average at 3 months (e.g., directly following treatment completion) reported higher PTSD symptoms than one's typical level at 6 months ($b = 0.03$, 95% CI [0.02, 0.04]; $\beta = 0.20$). Subsequently, this increased PTSD symptomology at 6 months was associated with reporting more days of homelessness than one's typical average at 12 months ($b = 0.35$, 95% CI [0.08, 0.62]; $\beta = 0.08$).

Hypothesis 3: Experience-Driven Risk Model

Here, we sought to explore how experiences of homelessness may drive long-term negative consequences such as increased PTSD symptomology or return to substance use posttreatment. Looking at Figure 1, we did not find support for any experience-driven risk during the posttreatment phase. That is, experiences of homelessness did not influence PTSD symptomology or substance use posttreatment. However, if we look at the treatment phase we did find that youth who reported more days of homelessness than their typical average at baseline reported higher prevalence rates of substance use ($b = 0.08$, 95% CI [0.03, 0.13]; $\beta = 0.05$) and

higher PTSD symptomology ($b = 0.06$, 95% CI [0.02, 0.10]; $\beta = 0.22$) than one's typical average immediately following treatment (3 months). If we continue to follow one of these pathways, we see that this greater substance use at 3 months is associated with reporting higher PTSD symptoms than one's typical average at 6 months, and subsequently this increased PTSD symptomology is associated with reporting more experiences of homelessness than one's typical average at 12 months.

Discussion

The current study provides the first longitudinal evidence, in populations who are not exclusively homeless, of temporal order of events linking PTSD symptomology, experiences of homelessness, and substance use following substance use treatment completion. Overall, we found support for both symptom-driven and experience-driven risk models. That is, even after controlling for lifetime experiences of victimization, we found PTSD symptomology to be a key mechanism leading to both homelessness and substance use following treatment (symptom-driven models). Further, we found that, while experiences of homelessness did not emerge as an important mechanism during the posttreatment phase, early experiences of homelessness (at baseline) were a catalyst that triggered a cascade of heightened PTSD symptomology and greater levels of substance use that eventually led to more days of homelessness. Results from the current study highlight the importance of untreated trauma symptomology, posttreatment, and a better understanding how youth homelessness (when entering treatment) can influence long-term problems. Our results suggest directions for initial assessment of homelessness among youth entering treatment as well as a focus on targeting PTSD symptomology among at risk youth entering substance use treatment.

Many youth who become homeless are either forcibly removed from their homes or leave in response to abuse by their caregivers. In general, results from the current study provide continued support for prior work on youth experiencing homelessness. For

Table 3
Final Autoregressive Latent Trajectory With Structured Residual Model: Associations Between Posttraumatic Stress Disorder (PTSD) Symptomology, Substance (Sub) Use, and Homelessness (Hmls)

Path estimates	Final model, parameter estimate [95% CI]
Within-person cross-lags	
Treatment phase	
Sub Use _{3m} on PTSD _t	.76 [−.09, 1.61]
PTSD _{3m} on Sub Use _t	.21 [.04, .38]
Hmls _{3m} on PTSD _t	.22 [−.01, .45]
PTSD _{3m} on Hmls _t	.06 [.02, .10]
Hmls _{3m} on Sub Use _t	.02 [−.05, .09]
Sub Use _{3m} on Hmls _t	.08 [.03, .13]
Posttreatment phase	
Sub Use _{6m} on PTSD _{3m}	.36 [.15, .57]
PTSD _{6m} on Sub Use _{3m}	.03 [.02, .04]
Hmls _{6m} on PTSD _{3m}	.15 [.02, .28]
PTSD _{6m} on Hmls _{3m}	.01 [−.001, .02]
Hmls _{6m} on Sub Use _{3m}	.03 [.01, .05]
Sub Use _{6m} on Hmls _{3m}	.04 [−.10, .07]
Sub Use _{12m} on PTSD _{6m}	.67 [.21, 1.11]
PTSD _{12m} on Sub Use _{6m}	.02 [.01, .04]
Hmls _{12m} on PTSD _{6m}	.35 [.08, .62]
PTSD _{12m} on Hmls _{6m}	−.001 [−.03, .02]
Hmls _{12m} on Sub Use _{6m}	.03 [.01, .05]
Sub Use _{12m} on Hmls _{6m}	−.01 [−.06, .04]
Autoregressive	
PTSD _{3m} on PTSD _t	1.03 [.77, 1.27]
Sub Use _{3m} on Sub Use _t	.40 [.36, .42]
Hmls _{3m} on Hmls _t	.04 [.01, .06]
PTSD _{t+1} on PTSD _t	.16 [.12, .19]
Sub Use _{t+1} on Sub Use _t	.40 [.36, .42]
Hmls _{t+1} on Hmls _t	.04 [.01, .06]
Residual (co)variances	
Sub Use _{ε_{t0}−ε_{t12}}	87.6 [84.9, 90.3]
PTSD _{ε_{t0}−ε_{t12}}	1.76 [1.68, 1.83]
Hmls _{ε_{t0}−ε_{t12}}	34.9 [33.9, 35.9]
Fit statistics	
−2LL	1,096,177.8
RMSEA	.03
SRMR	.02
CFI	.96

Note. CI = confidence interval; *t* = baseline; 3m = 3 months; 6m = 6 months; 12m = 12 months; ϵ = residual variance measured from baseline to 12 months; −2LL = −2 log likelihood; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; CFI = comparative fit index. Boldface indicates confidence intervals that do not include 0. RMSEA < .05 are considered to be representative of good model fit; SRMR < .08 are considered to be representative of good model fit; CFI > .90 are indicative of good model fit.

example, early work has found that a large majority of homeless and runaway youth have experienced abuse by a parent or adult caretaker (Whitbeck, Hoyt, & Ackley, 1997). Others have found that youth with more experiences of victimization report more time homeless, more substance use and more posttraumatic stress relative to those youth who experience less victimization (Hsu et al., 2018; Radu, 2017; Rice, Milburn, Rotheram-Borus, Mallett, & Rosenthal, 2005; Whitbeck, Hoyt, Johnson, & Chen, 2007; Whitbeck et al., 1999; Yoshioka-Maxwell & Rice, 2017). Prior studies have found that many homeless youth were abused before the age of four, and generally have higher rates of child abuse and neglect

than the general population (McManus & Thompson, 2008). Not surprisingly, experiences of abuse in the home or community is one of the most robust risk factors for substance using youth (Slesnick, Bartle-Haring, & Gangamma, 2006). In fact, youth who are current substance users or are in treatment were upward of 12 times more likely to report experiencing physical abuse and 18–21 times more likely to have a history of sexual abuse, compared to peers without substance use problems (Simpson & Miller, 2002).

The current study examines the within-person associations between substance use, traumatic symptoms, and days of homelessness. We found partial support for our symptom-driven hypothesis that PTSD symptoms would initiate long-term problems (e.g., return to substance use, homelessness) posttreatment. Specifically, we found (after controlling for lifetime victimization) a direct association between PTSD symptomology and increased experiences of homelessness at the within-person level of analysis. Interestingly, we also found a direct association between heightened levels of substance use and experiences of homelessness. These findings are in line with our hypotheses and prior literature. That is, research has found that exposure to violence and trauma related symptomology may drive experiences of homelessness among youth. Among longitudinal studies, prior research has found that somatic symptoms (e.g., physical health), symptoms of depression, and exposure to violence during adolescence are significant predictors of experiencing homelessness in young adulthood (van Den Bree et al., 2009). Other studies have found that experiences of victimization (e.g., witnessing or direct trauma exposure), and symptoms of depression or substance use disorder all predicted a higher probability of youth running away from home (Slesnick, Guo, Brakenhoff, & Feng, 2013; Tucker, Edelen, Ellickson, & Klein, 2011; Tyler & Bersani, 2008). While we did find a direct association between PTSD symptomology and heightened experiences of homelessness, we also found several ‘pathways’ that may lead to homelessness and return to substance use. Specifically, we found reporting more PTSD symptoms at treatment completion was associated with higher frequency of substance use (at the next time point). This higher rate of substance use was subsequently associated with increased experiences of homelessness 1-year posttreatment. While prior studies have posited that homelessness experiences should increase both posttraumatic stress and substance use (Hsu et al., 2018; Radu, 2017; Rice et al., 2005; Tyler et al., 2008; Whitbeck et al., 2007; Yoshioka-Maxwell & Rice, 2017), our results provide a more nuanced cascade of events in which homeless experiences are linked to posttraumatic stress and, subsequently, increased substance use. Theoretically, a symptom-driven perspective may aid in understanding what is happening at the individual level. Not only are traumatic events a driver of within-person differences in experiences of homelessness, but individual increases in traumatic symptoms relative to personal norms can lead to increased time spent homeless, or indirectly lead to increased time spent homeless through increased substance use.

Our results also provide some insight into clinical implications. In addition to finding PTSD as a driving factor predicting homelessness, we also found a full cross-lagged association between PTSD symptomology and substance use, which eventually leads to higher rates of homelessness experiences posttreatment. Thus, it may be that youth leaving substance use disorder treatment have residual, or unattended, trauma symptomology leading to a cascade of negative events. A substantial body of research has shown

high comorbidity among PTSD and substance use disorders (Clark, Lesnick, & Hegedus, 1997; Cottler et al., 1992; Driessen et al., 2008). In an effort to manage internalizing symptomatology (e.g., PTSD), youth may increase their use of substances, especially if the symptomatology (in this case PTSD) is not addressed. For example, theoretical and empirical evidence notes a functional relationship between substance use and trauma symptomatology, where substances are used in response to symptoms of internalizing symptomatology (Turner, Mota, Bolton, & Sareen, 2018). Recent research supports this notion such that, weekly fluctuations in PTSD symptomatology is associated with increased dependence symptoms (e.g., alcohol, cocaine, opiate), but not vice versa (Ouimette, Read, Wade, & Tirone, 2010). Others have found that, among a sample of adolescents in high school, the presence of PTSD symptomatology prospectively predicted onset of substance use disorders, but again, the reverse association was not found (Wolitzky-Taylor, Bobova, Zinbarg, Mineka, & Craske, 2012). Thus, it may be that when chronic strain (e.g., experiences of homelessness and/or trauma symptoms) produces internalizing psychopathology (e.g., PTSD), this operates as an additional strain that compounds maladaptive functioning, eventually leading to increased homelessness experiences.

Our results have implications for adolescents entering substance use treatment, especially for those with a history of homelessness. That is, we found partial support for an experience-driven risk model such that reporting more days of homelessness at baseline was a catalyst to multiple pathways of increased PTSD symptomatology, return to substance use, and greater homelessness experiences posttreatment. This indicates that, as practitioners, it may be important to focus first on youth's homelessness experience. Specifically, during the treatment intake process, screening for youths' experience of homelessness may inform providers on immediate actions to take, such as receiving housing services, reunification, or a further investigation into *why* youth are leaving home. In fact, our results point to homelessness as *the* driving factor that predicts increases in posttreatment PTSD symptoms. That is, it appears that when youth enter treatment and report heightened experiences of homelessness, it begins a cycle of problematic psychopathology that eventually lead youth back to homelessness.

In summary, our results point to a desperate need to include trauma-informed interventions for youth who have experienced early trauma and are reporting PTSD symptomatology. This is especially important in the context of youth's prior experience of homelessness, as our results point to a cascade of events leading to increased risk of homelessness stemming from trauma symptomatology immediately posttreatment. Prior research supports this notion with several studies noting, among those in treatment for substance use disorders, improvements in PTSD symptomatology are associated with sustained and continued improvements in substance use severity, but improvements in substance use were not found to improve PTSD symptomatology (Back, Brady, Sonne, & Verduin, 2006; Hien et al., 2010). Further, in a recent review on the treatment of comorbid PTSD and substance use disorders, Roberts, Roberts, Jones, and Bisson (2016) found that trauma-focused interventions that were delivered in conjunction with substance use disorder interventions were successful in reducing both PTSD symptomatology and frequency of substance use. Thus, long-term experiences of homelessness and returning to substance use following treatment completion may be mitigated by address-

ing trauma symptomatology among adolescents entering treatment for substance use problems.

Limitations and Conclusion

As with any study, there are limitations to the current article. First, the pathways elucidated here may not be generalizable to other groups of youth with experiences of homelessness and are not causal. This sample is drawn from youth in substance use treatment and the pathways linking homelessness, substance use, and traumatic stress may be different in populations drawn from street-based samples or samples of foster youth. Second, much prior work is quite concerned with the impact of peer influence in these processes and the current data set does not allow us to rigorously examine peer influence. Third, substance use was assessed via self-report, which may bias estimates. Fourth, we acknowledge that some bias may have been introduced due to attrition from specific groups of participants (i.e., male, racial/ethnic minorities, and those with prior lifetime experiences of homelessness). Finally, the majority of the current sample did not experience homelessness in the time between their intake and follow-up assessment(s). Strategies for modeling an outcome variable with excess zeros such as this have yet to be developed for more advanced models, and therefore our ability to accurately model this rather uncommon outcome may have been limited. However, we feel that the novelty and utility of this analytic strategy outweighs its limitations.

Future research would benefit from conducting similar within-person analyses with different populations of youth experiencing or at high risk for experiencing homelessness, such as street-based samples, samples of youth exiting juvenile justice programs, or samples drawn from the foster care system. Second, data sets that more rigorously track peer influence would add to a more complete understanding of the within-person connections over time, as prior work has hypothesized that substance use and mental health symptoms are impacted by longitudinal differences in peer engagement (Rice et al., 2005; Tyler et al., 2008; Whitbeck et al., 1999; Yoshioka-Maxwell & Rice, 2017). Third, it would be useful to examine a richer set of resilience factors as the risk amplification and abatement framework has suggested that successful engagement with positive peers, family, social services, and formal institutions can all impact the causal connections between homelessness experiences and behavioral health outcomes (Milburn et al., 2009; Rice, Stein, & Milburn, 2008). In conclusion, the current study extends primarily event-driven theoretical work, to consider individual level processes in conjunction with overarching event level predictors of homelessness. We found that PTSD symptomatology is a driving factor that both directly and indirectly influences experiences of homelessness posttreatment. Interventions may wish to incorporate trauma informed approaches for youth entering treatment as this may mitigate long-term experiences of homelessness and return to substance use.

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Received December 4, 2018

Revision received June 6, 2019

Accepted June 6, 2019 ■