Psychology of Addictive Behaviors

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Objective: Women who have experienced trauma report high rates of heavy episodic drinking (HED) and sleep problems. Prior work suggests that poor sleep exacerbates heavy alcohol use; however, potential mechanisms for this association are unclear. Consistent with the self-medication model, one possibility may be that women with a history of trauma are drinking at increased rates in order to cope with the affective consequences of poor sleep. To examine this possibility, the current study tested the role of drinking to cope motives as a mediator of prospective associations between sleep problems and HED among women who have experienced trauma. *Method:* Community women reporting a history of trauma ($N = 414$, $M_{age} = 21.8$, 59.9% White, 36.2% Black) completed self-report measures at baseline and 4 month and 8 month follow-ups. Measures of trauma exposure (Life Events Checklist [LEC]) and sleep problems (Cohen-Hoberman Inventory of Physical Symptoms—Revised [CHIPS-R]) were taken from baseline, drinking motives (Revised Drinking Motives Questionnaire) at 4 months, and HED at 8 months. *Results:* Findings supported an indirect association between sleep problems and later HED through increased drinking to cope motives ($b = .05$, 95% CI [.018, .108], $\beta = .05$). *Conclusion:* As hypothesized, drinking to cope accounted for associations between sleep problems and later HED. Findings underscore the potential value in addressing drinking to cope motives as a means of reducing HED, particularly among women with a history of trauma who are sleeping poorly.

Public Health Significance Statement
This study indicates that high rates of heavy alcohol use among women with a history of trauma who are sleeping poorly may be driven by motivations to drink in order to cope with distress. Findings point to sleep problems and drinking to cope as potential targets to reduce heavy episodic drinking (HED) among women who have experienced trauma.

Keywords: self-medication, sleep, alcohol drinking patterns, motivation, prospective studies

Heavy episodic drinking (HED) involves the consumption of four or more drinks for women or five or more drinks for men within two hours (National Institute on Alcohol Abuse and Alcoholism, 2016). HED is particularly common among emerging adults, with 25.1% of

individuals between the ages of 18 and 24 reporting past-year HED (Kanny et al., 2018). Over 70% of heavy episodic drinkers report experiencing at least one negative consequence of their alcohol use in the past year, including risky behavior (e.g., drinking and driving), interpersonal problems (e.g., relationship conflict), and worsened academic and workplace performance (Patrick et al., 2020). Other adverse outcomes of HED include poor physical health, such as chronic disease (e.g., stroke, diabetes, and heart disease; Rehm et al., 2010), and increased mortality (White et al., 2020).

Unfortunately, young adults with a history of trauma experience even higher rates of HED than the general population (Kanny et al., 2018). Approximately 40% of trauma survivors report past-year HED (Bray et al., 2013; Kilpatrick et al., 2007), with retrospective estimates of blood alcohol content indicating that young adult trauma survivors drink larger quantities of alcohol within a single episode, and consequently become more intoxicated, than those who have not experienced trauma (Norris et al., 2019). Although rates of HED are elevated among both men and women with a history of trauma, the link between trauma exposure and HED is particularly strong for women (Kachadourian et al., 2014), who also experience

especially high rates of physical health consequences related to heavy alcohol use (Caamaño-Isorna et al., 2017; White et al., 2020). These findings underscore the need to identify mechanisms that could be targeted among young adult women with a history of trauma to reduce risk for HED and associated adverse outcomes.

Role of Sleep Problems

In addition to high rates of HED, those with a history of trauma also frequently experience sleep problems, including insomnia (Jenkins et al., 2015), fatigue (Lerdal et al., 2010), sleep disturbances (e.g., midsleep and early morning wakening; Waldrop et al., 2008), and worsened sleep quality (DeGutis et al., 2018). Objective polysomnography data indicate that sleep problems are elevated among women compared to men following trauma exposure (Kobayashi & Mellman, 2012), suggesting that sleep may be particularly impaired among women with a history of trauma. Sleep problems are associated with lower quality of life (Lerdal et al., 2010) and increased psychological distress (DeGutis et al., 2018), as well as increased risk for developing posttraumatic stress disorder (PTSD) following trauma exposure (Babson & Feldner, 2010). These findings suggest that sleep problems are common among individuals with a history of trauma, especially women, and may contribute to negative outcomes.

Emerging evidence suggests that HED and sleep problems are not independent sequelae of trauma, but often co-occur and may be related in predictable ways. For instance, one longitudinal study with military veterans found that insomnia symptoms predicted increased drinking quantity over a month-long period (Miller et al., 2017). Similarly, in a separate sample of veterans, sleep disturbances, including difficulty falling or staying asleep, predicted later relapse to problematic drinking, suggesting that poor sleep may pose a risk to ongoing recovery (Williams et al., 2015). Finally, findings from a study testing potential reciprocal associations between sleep and drinking in a military veteran sample provided stronger support for a prospective path from insomnia to greater HED than for the reverse (i.e., HED predicting future sleep problems; Short et al., 2019).

Drinking to Cope as an Intervening Mechanism

The above findings document that sleep difficulties often serve as a precursor to HED, raising the possibility that these problems may be functionally related to each other. The self-medication model (Khantzian, 1997) offers a framework for understanding the nature of such relations among individuals who have experienced trauma. According to the self-medication model, alcohol use is driven by attempts to regulate or avoid unpleasant emotions (Cooper et al., 1995; Cox & Klinger, 1988; Hawn et al., 2020). Particularly relevant here are well-established findings that poor sleep disrupts affective processing (Goldstein & Walker, 2014), resulting in increased irritability, stress, and negative affect (Minkel et al., 2012). Moreover, individuals who are sleeping poorly demonstrate greater impairment in their ability to modulate responses to negative affect, including blunted emotional expression (Goldstein & Walker, 2014) and less effective use of cognitive reappraisal (Mauss et al., 2013). Women who have experienced trauma may be especially vulnerable to the emotional impact of poor sleep, consistent with findings that women perceive stressors as more

severe than men (Tamres et al., 2002) and that trauma survivors perceive themselves as less able to cope effectively with distress (Samuelson et al., 2017). Through the lens of self-medication, these findings suggest that trauma survivors may turn to alcohol as a means to alleviate the emotional distress brought on by sleep problems. Supporting this, women who have experienced trauma and report greater sleep problems also report greater drinking to cope motives (Nishith et al., 2001).

If women who have experienced trauma have trouble coping with sleep-related distress, they may turn to alcohol for relief. Evidence suggests that drinking to cope with negative affect is an especially important factor motivating problematic drinking among trauma survivors (McDevitt-Murphy et al., 2015). Moreover, women with a history of trauma report more stress-related drinking than their male counterparts (Young-Wolff et al., 2012). Particularly relevant to the current study, drinking to cope motives prospectively predict HED and increased alcohol use consequences (e.g., risky behavior) among young adult women with a history of sexual assault (Lindgren et al., 2012). Finally, decreases in drinking to cope motives have been found to be associated with decreases in HED following the implementation of a combined risk reduction intervention for alcohol use and sexual assault for emerging adults (Gilmore & Bountress, 2016), providing further evidence of the strong relation between drinking to cope and HED.

The Present Study

In sum, HED is a significant health problem commonly experienced by young adults with a history of trauma, particularly women. Sleep difficulties, which often contribute to increased negative affect and impaired emotion regulation, are also elevated among women with a history of trauma. Although sleep difficulties and HED often co-occur, little is known about *how* these problems may be related. The present study draws on the self-medication model to test the possibility that poor sleep is indirectly associated with HED through increased drinking to cope motives among young adult women who have experienced trauma.

In testing this hypothesis, the current study incorporates several methodological strengths. First, we utilized three waves of data collection (baseline and 4 and 8 month follow-ups) to test the proposed mediation model longitudinally. Second, in contrast to most previous studies that have examined sleep problems unidimensionally, we used a latent variable approach to capture distinct but related components of sleep difficulties (i.e., sleep disturbances, nightmares, and constant fatigue). Additionally, compared to prior work that has focused on predominantly male veteran samples, this sample consisted of young adult women reporting a variety of civilian trauma experiences—a group at particularly high risk for HED- and alcohol-related consequences (Langdon et al., 2017; Stappenbeck et al., 2013). Indeed, certain civilian traumatic experiences (e.g., sexual assault) are particularly common among community samples of women (Kilpatrick et al., 2013; Perkonigg et al., 2000), especially during young adulthood when risk for both sexual assault and HED is highest (Britton et al., 2015; Humphrey & White, 2000).

Finally, prior work examining prospective associations between sleep problems and HED has rarely accounted for other potentially relevant variables. In contrast, we controlled for several theoretically related covariates for a more stringent test of our hypothesis.

Specifically, consistent with evidence that sleep problems are prevalent among those with PTSD symptoms (Babson & Feldner, 2010), we controlled for PTSD symptoms (excluding items related to poor sleep) to examine the unique relation of sleep problems and drinking to cope. In addition, evidence suggests that there are racial and ethnic differences in rates of both sleep problems (Jackson et al., 2020) and alcohol use (Chartier & Caetano, 2010) that could influence the degree to which these concerns are present among women with a history of trauma. For instance, racial and ethnic minorities tend to report greater rates of sleep problems than White individuals (Chen et al., 2015; Jackson et al., 2020; Ruiter et al., 2011). Moreover, although White individuals engage in HED more frequently than Black, Latinx, and Asian individuals (Chartier & Caetano, 2010; Evans-Polce et al., 2015), social and medical consequences of alcohol use are more common among Black, Latinx, and Native American populations (Chartier & Caetano, 2010; Mulia et al., 2009). Thus, we controlled for racial/ethnic minority status in our analyses to account for the expected differences in sleep problems and HED between White and racial/ethnic minority women.

Method

Participants

Participants were 414 community women who were recruited at four sites (Jackson, Mississippi; Lincoln and Omaha, Nebraska; and Oxford, Ohio) to participate in a longitudinal study on women's sexual revictimization. The sample for the current study was drawn from the larger sample of 491 women who completed Wave 1. Eligibility criteria for the larger study required participants to be women between the ages of 18 and 25. To be included in the current analyses, participants had to report a potentially traumatic event on the Life Events Checklist (LEC) and complete the PTSD Checklist–Civilian Version in relation to the Criterion A event. Participants' ages at baseline ranged from 18 to 25 years ($M = 21.8$, $SD = 2.23$). The racial/ethnic composition of the sample was 59.9% White, 5.6% Latina or Hispanic, 36.2% Black or African American, 4.3% Asian, 3.6% American Indian or Alaskan Native, and 2.7% "other" (percentages exceed 100% because participants were allowed to select multiple categories). Participants primarily identified as heterosexual (83.7%), with the remaining participants identifying as bisexual (9.7%), lesbian or gay (4.1%), or "something else/don't know" (2.4%).

Measures

LEC (Gray et al., 2004)

The LEC is a 16-item measure that assesses the occurrence of potentially traumatic events (e.g., transportation accident, combat or exposure to a warzone, sexual assault) in a respondent's lifetime. Participants responded either "yes" or "no" to indicate whether they had experienced each event. Participants were also allowed to identify and describe any other potentially traumatic event that was not listed. Participants were then asked to indicate which of the potentially traumatic events they identified was "most traumatic" and whether they felt fear, helplessness, or horror at the time of that event. They were asked to complete the measure of PTSD symptoms

in reference to that event. Prior work supports the reliability and validity of the LEC (Gray et al., 2004).

PTSD Checklist–Civilian Version (Weathers et al., 1993)

The PTSD Checklist–Civilian Version (PCL-C) is a 17-item measure that was completed by participants to assess the degree to which they had experienced DSM-IV PTSD symptoms in the past month in relation to the Criterion A traumatic event they identified on the LEC. Participants rate the extent to which each PTSD symptom bothered them in the past month on a 5-point Likert-type scale ranging from 1 (*not at all*) to 5 (*extremely*). Consistent with prior work (DeGutis et al., 2018; King et al., 2017), an overall score reflecting PTSD symptom severity without sleep items was created by taking the sum of the 15 items that did not assess sleep problems. Reliability of the PCL-C is supported by prior work ($\alpha = .97$; Weathers et al., 1993). Internal consistency in the current sample was acceptable ($\alpha = .95$).

Cohen–Hoberman Inventory of Physical Symptoms–Revised (Campbell et al., 2008; Cohen & Hoberman, 1983)

The Cohen–Hoberman Inventory of Physical Symptoms–Revised (CHIPS-R) is a 35-item inventory assessing commonly experienced physical health symptoms that was revised for use with women with prior sexual victimization (Campbell et al., 2008; Cohen & Hoberman, 1983). Participants were asked to report the degree to which they have been bothered by each symptom over the past 4 months on a 5-point Likert-type scale ranging from 0 (*not at all*) to 4 (*extreme bother*). Three items from the CHIPS-R assessed sleep difficulties: sleep disturbances, ("sleep problems—can't fall asleep, wake up in the middle of night or early in morning"), nightmares ("nightmares"), and fatigue ("constant fatigue"). Consistent with our theoretical conceptualization of poor sleep as an underlying construct, these three items were modeled as indicators of a single factor latent variable. Validity and reliability of the CHIPS-R is supported by prior work (Campbell et al., 2008; $\alpha = .93$). Internal consistency between the three sleep items was adequate in the current sample ($\alpha = .71$) but did not reach .80 (which some researchers have suggested is a more accurate indicator of sufficient reliability; (Lance et al., 2006), further supporting our use of a latent variable.

Revised Drinking Motives Questionnaire (Cooper, 1994)

The Revised Drinking Motives Questionnaire (RDMQ) is a 20-item measure that participants completed to assess how often they drank alcohol in relation to common motives. Participants were asked to respond on a 6-point Likert-type scale ranging from 1 (*I never drink alcohol*) to 6 (*almost always/always*). The RDMQ has four subscales: coping, enhancement, social, and conformity motives. In the current study, only the 5-item subscale assessing coping motives for drinking (e.g., "Because it helps you when you feel depressed or nervous") was assessed. A drinking to cope score was created by taking the mean of all 5 items. Internal consistency of the RDMQ coping motives subscale is supported in prior work ($\alpha = .84$; Cooper, 1994) and ranged from .93 to .94 across occasions in the current sample.

HED (Testa et al., 2010)

Consistent with prior work examining HED (Caamaño-Isorna et al., 2017; Kanny et al., 2018), a single item was used to assess the frequency of HED based on National Institute on Alcohol Abuse and Alcoholism (NIAAA) criteria for women ("Since you last participated, how often have you consumed 4 or more alcoholic drinks on a single occasion?"). Participants were provided examples of standard drinks when completing this item ("1 drink = 12 oz beer, 1.5 ounces hard liquor, 6 ounces wine"). Participants responded on a 5-point Likert-type scale ranging from 0 (*never*) to 4 (*4 or more times a week*).

Procedure

The Institutional Review Boards (IRBs) for all participating sites approved of the study procedures. A list of potential participants who met eligibility criteria (i.e., women between the ages of 18 and 25 who lived in one of the study site locations) were identified through Survey Sampling International (SSI). Recruitment letters were sent to randomly selected women from this list inviting participation in a study examining women's life experiences. In addition, participants were recruited using community advertisements at each of the sites. All participants provided written informed consent and were compensated $75 for the baseline assessment, $25 for Wave 2 (4 month follow-up), and $50 for Wave 3 (8 month follow-up).

Participants completed self-report questionnaires in Qualtrics at baseline, 4 month follow-up (Wave 2), and 8 month follow-up (Wave 3). For the current analyses, scores on the LEC, PCL-C, and CHIPS-R were taken from baseline. Scores on the RDMQ were taken from baseline and 4 month follow-up. Lastly, scores of HED were taken from 4 month and 8 month follow-ups. Thus, our measures were collected in accordance with the proposed temporal ordering of the tested path and we were able to implement autoregressive controls when appropriate (i.e., controlling for baseline RDMQ when predicting 4 month RDMQ; controlling for 4 month HED when predicting 8 month HED).

Data Analytic Plan

Longitudinal data were analyzed using SPSS Version 22 for descriptive statistics and SEM techniques in Mplus (Muthén & Muthén, 2017) for testing measurement and structural models. Due to attrition across repeated measurements, there were missing data for scores of drinking to cope and HED at each follow-up assessment. The covariance coverage for the primary mediation model ranged from 77% to 99% ($N = 414$; see Table 1 for *n* for each

variable). Missing data were addressed using full maximum likelihood (ML) estimation (Enders, 2010). Thus, all 414 participants were included in the analyses. Data analyses were conducted in three phases. First, preliminary analyses and descriptive statistics were conducted in SPSS to determine whether the data met the basic assumptions of SEM. Next, confirmatory factor analysis was conducted in Mplus to determine the fit of the measurement model representing sleep problems (Byrne, 2001) with self-reported sleep disturbances, nightmares, and fatigue as indicators. Scaling was achieved by fixing the variance of the latent variable to 1.00, which resulted in standardized latent scores. There were no correlated disturbances. The final phase of data analysis included the simultaneous testing of the measurement and structural models in Mplus. To test the role of coping motives for alcohol use in explaining the association between sleep problems (modeled using a latent variable) and HED, a mediation model was tested and the hypothesized indirect effect was estimated. Given our use of prospective data, autoregressive controls were included in the model. Specifically, baseline drinking to cope was included as a covariate in the model when predicting 4 month drinking to cope (mediator) and 4 month HED was included as a covariate in the model when predicting 8 month HED (outcome). In addition to autoregressive controls, PTSD symptoms (without sleep items) were included as a covariate in the model when predicting 4 month drinking to cope. Racial/ethnic minority status (coded as 1 = racial/ethnic minority, 0 = non-Latinx White) was included in the model when predicting 4 month drinking to cope and 8 month HED. All exogenous variables (i.e., sleep problems, baseline coping motives, 4 month HED, PTSD symptoms, and racial/ethnic minority status) were covaried. Further, 4 month drinking to cope and 4 month HED were covaried as they were collected at the same timepoint. Bias-corrected bootstrapping with 5,000 samples was used to obtain 95% confidence intervals (CIs) for the indirect effects (Preacher et al., 2007). If the CI does not include zero, an indirect effect is supported. Bootstrapping is preferred over the traditional Sobel test because it performs well in small samples, maximizes power, and does not assume normal distributions (Preacher & Hayes, 2008).

Results

Descriptive Statistics

In the current sample, the most common potentially traumatic events were "rape or other unwanted sexual experience" (33.8%), "sudden, unexpected death" (19.6%), and "transportation accident" (10.9%). These high rates of sexual victimization are consistent with estimates from large epidemiological studies examining the prevalence of sexual violence among community women (26.1%, Scott et al., 2018; 42.4%, Kilpatrick et al., 2013). The mean PCL-C score was 32.9 ($SD = 15.7$) with sleep items included and 29.1 ($SD = 13.9$) with sleep items removed, suggesting that the average participant was experiencing clinically significant PTSD symptoms approaching the cut-point for a probable PTSD diagnosis (i.e., score of 33; Weathers et al., 1993). Consistent with this, 40.8% of participants reported levels of PTSD symptoms that met or exceeded this threshold (i.e., scores of 33 and above) when all items were included. On average, participants reported that they experienced their most traumatic event around the age of 16 ($M_{age} = 16.3$, $SD = 4.9$).

Table 1
Descriptive Statistics for Primary Study Variables

	Timepoint	Wave	*n*	*M*	*SD*	Range
1. Sleep disturbances	Baseline	1	410	1.81	1.38	0–4
2. Nightmares	Baseline	1	413	.93	1.18	0–4
3. Fatigue	Baseline	1	411	1.26	1.37	0–4
4. Drinking to cope	Baseline	1	412	12.04	6.24	5–30
5. Drinking to cope	4 months	2	355	11.30	6.09	5–30
6. Heavy episodic drinking	4 months	2	358	.95	1.02	0–4
7. Heavy episodic drinking	8 months	3	338	.90	1.02	0–4

Regarding rates of sleep problems and HED, 76.6% of participants reported experiencing sleep disturbances, 48.7% reported nightmares, and 57.4% reported fatigue over the past 4 months at Wave 1. Further, approximately half (53.8%) of the sample reported consuming four or more drinks on a single occasion in the past 4 months, consistent with NIAAA guidelines for HED. Specifically, 27.8% of participants reported that they engaged in HED monthly or less, 17.5% reported HED two to four times per month, 7.4% reported HED two to three times per week, and 1.2% reported HED four or more times a week at Wave 3. The remaining descriptive statistics and correlations for the primary study variables are reported in Table 1 and 2. All variables were within acceptable ranges for skewness and kurtosis. Indicators of the hypothesized latent factor of sleep problems (i.e., sleep disturbances, nightmares, and fatigue) were each significantly correlated in the expected positive direction. Nightmares and fatigue at baseline were positively associated with HED at 4 month and 8 month follow-ups. Sleep disturbances at baseline were positively associated with HED at 4 month follow-up but were not associated with HED at 8 month follow-up. All sleep variables at baseline were positively associated with drinking to cope at baseline and 4 month follow-up. Lastly, drinking to cope at baseline and 4 month follow-up were positively associated with 4 and 8 month HED. Regarding our covariates, PTSD symptoms at baseline were positively associated with sleep disturbances, nightmares, and fatigue at baseline, drinking to cope at baseline and 4 months, and 4 month and 8 month HED. Additionally, identifying as a racial/ethnic minority was associated with significantly lower levels of nightmares, 4 month drinking to cope, and 4 and 8 month HED. Racial/ethnic minority status was not significantly associated with sleep disturbances, fatigue, or drinking to cope at baseline. Given our use of prospective data, we conducted attrition analyses to determine whether participants who completed follow-up assessments differed significantly from those who did not. Participants who did not complete Wave 2 reported greater PTSD symptoms $t(412) = -3.1$, $p < .002$, more nightmares $t(411) = -2.45$, $p < .02$, and lower income $t(409) = 2.15$, $p < .03$ at Wave 1 than those who did complete the Wave 2 assessment. Women who did and did not complete the Wave 2 assessment did not differ on age, racial/ethnic background, fatigue, sleep disturbances, or drinking to cope at Wave 1 (all p's $> .18$). Next, participants who did not complete Wave 3 reported greater PTSD symptoms at Wave 1, $t(412) = -3.1$, $p < .002$, but did not differ on other demographic or study variables at Wave 1 (all p's $> .13$). However, all 414 participants who completed Wave 1 were retained in the analyses using ML estimation.

Measurement Model

To specify the measurement model included in the overall structural model, we used three indicators of a higher-order latent construct reflecting global sleep problems. Indicators were represented by discrete items from the CHIPS-R. Because the measurement model was just identified, the global fit was perfect. Component fit was examined, and standardized factor loadings were .77 for sleep disturbances, .54 for nightmares, and .70 for constant fatigue (all p's $< .001$), indicating that each of the three items significantly loaded onto the latent variable. Approximately 60% of the variance in sleep disturbances was accounted for by the latent variable, 30% of the variance in nightmares, and 49% of the variance in fatigue. Thus, the latent construct appears to reflect global sleep problems shared across these dimensions.

Structural Model

Estimation of the structural model yielded satisfactory global fit, $\chi^2(14, N = 414) = 36.94$, $p < .001$, comparative fit index (CFI) = .972, Tucker Lewis index (TLI) = .939, root mean square error of approximation (RMSEA) = .063, and standardized root mean square residual (SRMR) = .029. For the CFI and TLI, values of .95 or greater reflect adequate fit; for the SRMR and RMSEA, values up to .08 indicate adequate fit (MacCallum et al., 1996). As shown in Figure 1, when controlling for baseline drinking to cope, PTSD symptoms, and racial/ethnic minority status, greater sleep problems at baseline predicted increased drinking to cope 4 months later ($b = 1.34$ [$SE = .42$], $p < .001$, $\beta = .22$). Further, drinking to cope at 4 month follow-up predicted increased HED at 8 month follow-up when controlling for 4 month HED and racial/ethnic minority status ($b = .04$ [$SE = .01$], $p < .001$, $\beta = .23$). There was no direct relation between sleep problems at baseline and HED at 8 month follow-up when accounting for covariates ($b = -.05$ [$SE = .06$], $p > .47$, $\beta = -.05$). Finally, there was an indirect relation of greater sleep problems to increased HED at 8 month follow-up via greater 4 month drinking to cope when accounting for covariates ($b = .05$, 95% CI [.018, .108], $\beta = .05$). The overall model accounted for 44.9% of the variance in 4 month drinking to cope and 43.6% of the variance in 8 month HED.

Table 2
Correlations Between Study Variables

	Wave	1	2	3	4	5	6	7	8	9
1. Sleep disturbances	1	—	.42***	.54***	.18***	.24***	.13*	.07	.34**	−.02
2. Nightmares	1		—	.38***	.18***	.22***	.17***	.19***	.43***	−.14**
3. Fatigue	1			—	.25***	.31***	.19***	.16**	.43***	−.08
4. Drinking to cope	1				—	.63***	.43***	.44***	.30***	−.06
5. Drinking to cope	2					—	.54***	.51***	.30***	−.15**
6. Heavy episodic drinking	2						—	.64***	.13*	−.26***
7. Heavy episodic drinking	3							—	.16**	−.21***
8. PTSD symptoms	1								—	−.01
9. Racial/ethnic minority status	1									—

Note. PTSD = posttraumatic stress disorder.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 1
Path Analyses for SEM Model
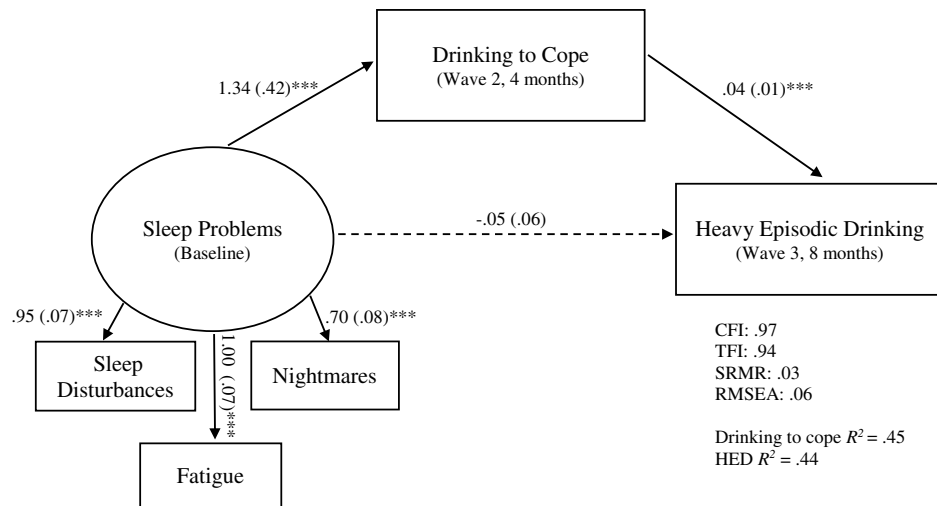
Note. Unstandardized coefficients (SE) are reported for each path. Autoregressive controls were implemented so that baseline drinking to cope was controlled for when predicting 4 month drinking to cope (mediator) and 4 month HED was controlled for when predicting 8 month HED (outcome). PTSD symptoms were controlled for when predicting 4 month drinking to cope (mediator) and racial/ethnic minority status was controlled for when predicting 4 month drinking to cope (mediator) and 8 month HED (outcome). 4 month drinking to cope (mediator) and 4 month HED (covariate) were covaried. An indirect effect of sleep problems at baseline on HED 8 months Later was present via 4 month drinking to cope when accounting for covariates (b = .05, 95% CI [.018, .108], β = .05.). * $p < .05$.   ** $p < .01$.   *** $p < .001$

Discussion

This study examined the role of drinking to cope as a mechanism accounting for associations between sleep problems and subsequent HED among young adult women with a history of trauma. As predicted, and consistent with the self-medication model, drinking to cope explained the association between sleep problems and later HED. The implications of these findings for understanding and reducing rates of HED among young adult women with a history of trauma are discussed in more detail below.

Our finding that sleep problems and HED were prevalent in this diverse sample of young adult women with a history of trauma aligns with prior literature documenting similar problems in populations with trauma exposure (Kilpatrick et al., 2007; Kobayashi & Mellman, 2012). Approximately 50% of the participants reported nightmares and fatigue, and over 75% reported sleep disturbances. The incidence of nightmares was slightly lower than prior estimates among trauma survivors (55–80%, Davis & Wright, 2006), which may reflect our use of a subthreshold sample with lower overall PTSD symptom severity. However, rates of the remaining sleep problems were consistent with prior estimates of fatigue (Waldrop et al., 2008) and sleep disturbances (DeGutis et al., 2018) among other samples with trauma histories, and were elevated compared to rates in nonclinical samples of young adult women (e.g., 55% reporting sleep disturbances, 33% reporting daytime fatigue; Fatima et al., 2016). Together, findings indicate that many—perhaps a majority—of young adult women who have experienced trauma are likely experiencing poor global sleep. As a result, it may be valuable to assess multiple domains of sleep-related impairment in order to capture overall sleep quality among women who have experienced

trauma. Finally, it appears that young adult women with a history of trauma are engaging frequently in HED. In fact, the rates of HED found here (54%) are even higher than prior estimates among women with a history of sexual assault (up to 42%; Kilpatrick et al., 2007), further supporting the need to address HED among this population.

Findings indicated that increased sleep problems predicted greater motivation to consume alcohol in order to cope with negative affect among young adult women with a history of trauma. These results extend previous cross-sectional work showing links between sleep problems and the use of alcohol as a coping strategy (Nishith et al., 2001) by demonstrating that sleep problems predict later levels of drinking to cope. Thus, the degree of sleep problems experienced by women who have experienced trauma may help explain previously demonstrated high rates of drinking to cope in this population (Gilmore & Bountress, 2016). One explanation for this association may be that trauma survivors who experience sleep problems are more likely to use avoidant coping strategies, such as alcohol use (Brooks et al., 2019), in response to the distress associated with poor sleep (Minkel et al., 2012). Indeed, poor sleep has been linked to impaired affective coping (Mauss et al., 2013; Spoormaker & Montgomery, 2008), suggesting that drinking to cope may be one such example of maladaptive coping that is more likely to be used in the context of poor sleep.

Increases in drinking to cope motives, in turn, predicted increases in the frequency and consequences of HED. This finding supports the well-established link between drinking to cope motives and later heavier drinking across nonclinical populations and individuals with a history of trauma (Holahan et al., 2001; Lindgren et al., 2012). Although there are varied motives for alcohol use (e.g., conforming

to social norms, enhancing positive feelings; Cooper, 1994; Patrick et al., 2011), drinking to cope with psychological distress appears to confer particular vulnerability for riskier drinking such as HED. It is possible that drinking motives focused on coping are related to greater reliance on alcohol due to broader deficits in coping skills and less control over one's degree of alcohol consumption (Cooper et al., 1995). Because those with prior experiences of trauma tend to experience high levels of general psychological distress, they may be more likely to resort to drinking in the absence of more adaptive coping strategies (e.g., social support, mindfulness) and have greater difficulty regulating their alcohol use, leading to increased HED.

These individual linkages, when examined as a whole, are consistent with a process motivated by self-medication. As expected, findings suggest that associations between sleep problems and later heavy drinking among young adult women who have experienced trauma are driven by efforts to alleviate psychological distress by drinking. The affective consequences of poor sleep may set the stage for increased negative affect (Goldstein & Walker, 2014; Spoormaker & Montgomery, 2008) and bolster the perceived need to escape unpleasant emotions, particularly among trauma survivors who report less confidence in their ability to manage and cope with distress (Samuelson et al., 2017). Consistent with the self-medication model, women who have experienced trauma may then turn to alcohol in an effort to manage the affective impairment brought on by poor sleep and reduce unwanted emotions. Findings are consistent with a substantial body of literature supporting the self-medication model among women with a trauma history (Langdon et al., 2017), and point to poor sleep as a novel context in which women who have experienced trauma may be especially susceptible for heavy drinking to regulate distress.

Limitations and Future Directions

Although findings of this study advance current knowledge regarding the role of sleep problems in predicting alcohol use for self-medication among women who have experienced trauma, there are several limitations to note. Our sample consisted of only women, an important population to study due to their elevated rates of sleep problems (Kobayashi & Mellman, 2012) and HED (Kachadourian et al., 2014); nevertheless, this precludes the generalizing of findings to men with a history of trauma, who also experience higher rates of poor sleep (DeGutis et al., 2018) and HED (Bray et al., 2013) than the general population (Fatima et al., 2016; Kanny et al., 2018). In addition, a strength of the current study was the racial/ethnic diversity of the sample. Nonetheless, relatively small sample sizes across particular racial/ethnic minority groups limited our ability to test hypotheses specific to race and ethnicity, which is an important avenue of future research. For instance, considering lower rates of HED among Black, Latinx, and Asian individuals compared to those who are White (Chartier & Caetano, 2010; Evans-Polce et al., 2015), research could examine protective factors that may help buffer against HED among these populations. Moreover, examining possible risk (e.g., minority stress) and resiliency (e.g., social support) factors that could moderate associations between poor sleep and HED through drinking to cope could be an important next step toward understanding racial differences in sleep and alcohol use.

The current study focused on several aspects of sleep impairment that are known to be elevated among individuals with a history of trauma. Our latent variable measure of sleep was comprised of items from a larger physical health inventory that was not originally developed as a standalone measure of sleep-related impairment. However, other studies examining sleep problems among individuals with a history of trauma have used latent variables with similar indicators, suggesting that our measure was able to capture important aspects of sleep impairment for this population (King et al., 2017). Indeed, some of these problems (i.e., nightmares and fatigue) are best assessed through self-report and are likely to be particularly relevant to trauma survivors (Babson & Feldner, 2010; Davis & Wright, 2006). However, other sleep problems related to trauma, such as sleep disturbances, are difficult to report on accurately and can be assessed objectively (e.g., using actigraphy, polysomnography; Sadeh, 2015) for more precise and sensitive measurements. Further, evidence that objective and subjective assessments of sleep difficulties are often divergent (including among women with a history of trauma) suggests that these indices could represent distinct parameters of sleep (Werner et al., 2016). Future work should incorporate these objective measures of sleep disturbances, as well as other aspects of sleep that were not measured in the current study (e.g., sleep quantity, regularity, efficiency) to further enhance our understanding of how sleep problems may influence alcohol use in populations with prior trauma.

Although findings support a unique relation of sleep problems to HED through drinking to cope after controlling for several relevant variables, it is important to note that the standardized indirect effect was small ($\beta = .05$). This suggests that additional variables likely influence risk for HED among women who have experienced trauma. For instance, it is possible that young adult women with a history of trauma drink as a means of social support, to conform with peer norms around heavy drinking, or to improve their sleep (e.g., to help them fall or stay asleep). Because the current study did not include data related to other common reasons for drinking, we were unable to test alternate motives as potential mechanisms underlying the relation of sleep problems to HED. Future studies should examine these factors to capture the full range of reasons that women who have experienced trauma may be engaging in HED at such high rates.

The current study provided a strong longitudinal test of the hypothesized mediation model; however, the data were not collected experimentally, which precludes causal conclusions. Future studies would benefit from the experimental manipulation of the amount or quality of sleep that an individual receives (e.g., using a sleep deprivation paradigm; Alhola & Polo-Kantola, 2007) in order to examine whether poorer sleep predicts greater endorsement of drinking to cope and in turn, greater next-day heavy drinking. Such studies could also assess alcohol use in the laboratory through the use of ad libitum alcohol consumption paradigms to examine whether individuals drink more (e.g., amount consumed, peak BAC) after receiving less sleep.

Another helpful direction for future research would be the use of ecological momentary assessment (EMA) techniques to investigate more temporally proximal associations between sleep, drinking to cope, and HED. EMA could be used to examine if trauma survivors endorse drinking to cope motives more strongly on days when they experience poorer sleep than usual. Similarly, given evidence of

reciprocal associations between sleep problems and heavy alcohol use (Fucito et al., 2018), EMA could be helpful in testing bidirectional associations between the constructs (e.g., sleep problems predict heavier alcohol use the following day, leading to impaired sleep quality later that night). If findings confirm that either construct is likely to increase risk for the other, then intervening to address sleep problems and HED concurrently might be beneficial. EMA could also be used to examine novel mechanisms and outcomes posited by the current study. For instance, it would be valuable to assess the affective consequences of poor sleep (e.g., increased negative affect, emotional distress) in order to test our supposition that these consequences account for the association between sleep problems and drinking to cope. The potential role of sleep problems in the use of substances other than alcohol (e.g., cannabis) could also be examined. Indeed, trauma survivors report using cannabis to cope with distress (Bujarski et al., 2012) and to increase the quality and duration of sleep (Goodhines et al., 2019).

Finally, the current study has several implications for future intervention research with young adult women who have experienced trauma. Such work should examine whether addressing sleep problems leads to reductions in drinking to cope and subsequent HED among women with a history of trauma. One possible avenue could involve investigating whether evidence-based treatments designed to improve sleep among trauma survivors (e.g., Davis & Wright, 2006) could also help reduce risk for HED. Moreover, consistent with prior findings that targeting drinking to cope can help decrease HED (Gilmore & Bountress, 2016), future research could examine the potential benefits of incorporating drinking motives into interventions designed to reduce HED among women with a history of trauma. Such strategies could include educating women about linkages between poor sleep and negative affect to help them recognize and avert tendencies to drink in response to sleep-related distress. These efforts might also involve increasing women's access to and use of adaptive coping strategies in response to distress (e.g., mindfulness, acceptance, cognitive reappraisal) to decrease the use of alcohol for coping reasons. Pending future research, it is possible that women who have experienced trauma could benefit from examination of these strategies to reduce risk for drinking to cope and, in turn, HED.

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