Does loneliness before the age of twelve indirectly affect impaired control over drinking, alcohol use, and problems through perceived stress?

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ABSTRACT
Background: Loneliness is the pain of feeling socially isolated from others (Russell et al., 1980). The Stress-Dampening Hypothesis (Marlatt, 1987; Sayette, 1993; Sher, 1987) posits that individuals drink to alleviate negative affect. To date, it has not been determined whether loneliness experienced as a child can indirectly influence at-risk patterns of alcohol use through the mediating mechanism of stress and impaired control. Impaired control over alcohol use (IC) is the difficulty adhering to one’s own self-prescribed limits on drinking behaviors (Heather et al., 1993). Impaired control is an at-risk pattern of use that is particularly relevant to emerging adults. Methods: We examined the direct and indirect relationships between childhood loneliness, stress, IC, and alcohol-related problems with a structural equation model. In a college student sample, we utilized a (k = 20,000) bootstrap technique and a model indirect command in Mplus to examine potential mediational pathways. Cisgender sex was included as a covariate. Results: Loneliness was directly linked to stress as well as to alcohol-related problems. Higher levels of loneliness were indirectly linked to both more alcohol use and alcohol-related problems through more stress and in turn, more impaired control over drinking. Conclusions: The current study is consistent with the Stress Dampening Hypothesis (Marlatt, 1987; Sayette, 1993; Sher, 1987). Our findings suggest that therapeutic interventions combating loneliness in childhood may disrupt the stress-dampening pathway to dysregulated alcohol use in emerging adulthood.

“The need to belong is a fundamental motivator of human behavior” (Baumeister & Leary, 1995, p. 497; Maslow, 1943).

1. Introduction

Loneliness is a plague affecting one third of individuals among industrialized countries (Cacioppo & Cacioppo, 2018) and occurs when there is a discrepancy between an individuals’ desired and achieved social contact (Peplau & Perlman, 1979). Loneliness is subjective rather than contingent on objective measures of social isolation (Courtnia & Knapp, 2017). Even when social interaction is plentiful, such as the first semester of college, loneliness may still be experienced (Curtona, 1982). Cacioppo et al.’s (2006) Evolutionary Model of Loneliness suggests the averseness of perceived social isolation functions through social pain and reward to stimulate social reconnection. Therefore, when the need to belong is not satisfied, cognitive, behavioral, and neurophysiological distress occurs (Cacioppo et al., 2006). Eisenberg’s (2003) neuroimaging findings indicate that social exclusion elicits a pattern of neural activation similar to physical pain. Moreover, social connectedness is a rewarding experience (Billing et al., 2002).

Loneliness is normative during development (Ladd & Ettekal, 2013) and can be transient or enduring across all ages (Qualter et al., 2015). Children feel and understand loneliness as a concept distinct from social isolation, at ages as young as five years old (Asher & Paquette, 2003). Perceived social isolation in childhood predicts social skill deficits, sleep dysregulation, depression, suicidality, and substance use in emerging adulthood (Harris et al., 2013; Jones et al., 2011; Qualter et al., 2010; Schinka et al., 2013). In a 12-year longitudinal study, Qualter and colleagues (2013) found children with sustained loneliness over time (ages 5–17 years old) consumed alcohol more frequently and in greater quantity at age 17 compared to non-lonely children. Based upon the extant literature, we hypothesize that recalled childhood loneliness before the age of 12 will directly predict more alcohol-related problems among emerging adults (Russell et al., 1980).

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1.1. Stress as an outcome

Cacioppo and colleagues (2000) measured salivary cortisol throughout the day, and found that chronic loneliness was associated with increased cortisol. As cortisol is a hormone highly associated with stress, and indicative of hypothalamic-pituitary-adrenocortical (HPA) axis activity, its increased presence relative to state and trait loneliness demonstrates the complex association between loneliness and stress reactivity (Doane & Adam, 2010). Lonely participants, relative to non-lonely participants, show atypical physiological stress reactivity (Brown et al., 2018), higher blood pressure (Ong et al., 2012) and more pro-inflammatory biomarkers (Steeptoe et al., 2004), as well as reduced heart rate (Cacioppo et al., 2002) and cardiac output (Hawley et al., 2003) when enduring acute stress. Hawley et al. (2006) found that loneliness was associated with more self-reported perceived stress. While the relationship between stress and cortisol excretion is strong (Goldman et al., 2005), recent literature has only recently begun to consider perceived stress as a mediator for loneliness and other health-related problems (Huang et al., 2019; McHugh & Lawlor 2013). Therefore, this study hypothesizes perceived stress in the last month as a potential mediator between childhood loneliness and alcohol-related problems in emerging adulthood.

1.2. Impaired control over alcohol (IC)

Impaired control over alcohol (IC) refers to the inability to limit or abstain from drinking when there is an intention to do so (Heather et al., 1993). According to Patock-Peckham et al. (2001), IC is a failure of appropriate self-regulation specific to the drinking context. Previous research has found that IC mediates the relation between childhood adversity (i.e. maltreatment and trauma) to alcohol use among emerging adults (Frohe et al., 2020; Patock-Peckham et al., 2020). Hussong and Chassin (1994) found that impulsivity mediates the relation between states of negative affect (i.e., depression) and alcohol use. Patock-Peckham & Morgan-Lopez (2006) characterized impaired control as impulsivity specific to the drinking context. Albeit, IC additionally implicates the facet of intention to limit or abstain from drinking, while impulsivity does not (Bickel & Marsch, 2001; Heath et al., 1993).

Considering the strong associations between impulsivity and impaired control (Leeman et al., 2012; Patock-Peckham & colleagues 2006; 2011; Wardell et al., 2016), as well as between depression and loneliness (Heinrich & Gullone, 2006), this study sought to explore the more specific pathways between loneliness, stress, and multiple drinking outcomes (e.g. IC, alcohol use, and alcohol-related problems) all in one pathway.

The Stress Dampening Hypothesis (Marlatt, 1987; Sayette, 1993; Sher, 1987) suggests that alcohol is a substance often used to alleviate negative affect. Yet, evidence for stress-induced drinking in self-administration studies is inconsistent. Some ad libitum studies fail to find a link; these studies utilized negative mood induction and anticipated shock paradigm manipulations (Cyders et al., 2016; Higgins & Marlatt, 1973). Other studies using the Trier Social Stress Test (TSST) manipulation find a causal link (McGrath et al., 2016; Patock-Peckham et al., 2022; Thomas et al., 2011). The latter evidence is more consistent with studies regarding the impact of childhood trauma on stress reactions such as insomnia (Noudali et al., 2022) and PTSD (Patock-Peckham et al., 2020). Furthermore, coping motives for drinking are positively related to increased IC (Canning et al., 2020; Leeman et al., 2007). Impaired control is associated with increased alcohol use quantity and frequency in college students (Frohe et al., 2020; Patock-Peckham & colleagues 2018; 2020), and prospectively predicts alcohol use disorder (AUD; Leeman et al., 2009; Patock-Peckham et al., 2019).

Conceivably, IC is a potential mechanism by which stress-sensitive individuals engage in problematic drinking behaviors.

1.3. Cisgender sex differences

According to Park et al. (2020), loneliness has more pronounced negative impacts on cognitive deficits for men than for women. Further, stress reactivity appears to differ between men and women (Peltier et al., 2019); women are more reactive to stress (Ramchandani et al., 2018). For instance, Patock-Peckham et al.’s (2022) alcohol self-administration study found that women were more likely to engage in heavy episodic drinking after just experiencing an acute stressor (i.e. Trier Social Stress Test; TSST) than were men. In addition, women show substantial increases in dysregulated binge and heavy episodic drinking (Hingson et al., 2017; Guinle & Sinha, 2020). Although men drink more often, in greater quantity, and report more heavy episodic drinking (Nolen-Hoeksema, 2004) women are catching up with alcohol use disorders (AUDs). Grant et al., (2017) reported an 84% increase in AUD among women versus a 35% increase among men in the last decade. Hence, one must control for gender differences in models of loneliness. Albeit we did not have specific predictions regarding our loneliness pathway through stress and IC, regarding cisgender sex differences, we did feel it was wise to include gender as a covariate due to the aforementioned studies above.

1.4. Hypotheses

Based upon Cacioppo et al.’s (2006) Evolutionary Model of Loneliness, sustained loneliness may have long-term effects on stress reactivity. Thus, we predict that childhood loneliness (prior to the age of 12) is positively linked to perceived stress in emerging adulthood. Additionally, in tandem with the Stress Dampening Theory (Marlatt, 1987; Sayette, 1993; Sher, 1987), we hypothesize that there is an indirect relationship between childhood loneliness and alcohol misuse; this link is expected to be mediated by both stress, and in turn, IC. As previous literature has found that IC over drinking is an indirect outcome of adverse childhood experience (Frohe et al., 2020; Noudali et al., 2022; Patock-Peckham et al., 2020), we hypothesize novel direct and indirect relationships between childhood loneliness and IC.

2. Methods

2.1. Participants

Our sample included 310 university students (154 women, 156 men) who were 18 years or older and proficient in English to be able to give informed consent based on the requirement of our local IRB. All participants received 1 h of course credit and the full survey had an average response time of 54 min on the Qualtrics online survey tool. We protected the anonymity of participants by deleting student e-mails and IP addresses after awarding course credit. The consent form stated that the study would ask questions regarding their past and present experiences, personality traits, and substance use. Our sample included 85% current drinkers of alcoholic beverages and 12.3% claiming under aged drinking after just experiencing an acute stressor (i.e. Trier Social Stress Test; TSST).

2.2. Measures

2.2.1. UCLA loneliness scale

The UCLA loneliness scale (Version 3; Russell et al., 1996; Russell et al., 1980) is a well-validated 20-item questionnaire that measures feelings of perceived social isolation and dissatisfaction with the quality of relationships. We asked the questions prefixed with “before the age of 12” to measure childhood loneliness. The scale includes questions such as “Before the age of 12, how often did you feel isolated from others?” and “Before the age of 12, how often did you feel that people were...
around you but not with you?” The response options were rated from 1 (never), 2 (rarely), 3 (sometimes) and 4 (often). The α reliability was 0.97.

### 2.2.2. Perceived Stress Scale-10
The PSS-10 (Cole, 1999) measures the subjective experience of stress by assessing feelings of disontent with the uncontrollability of life in the past month. The 10-items consist of questions such as “how often have you felt that you were unable to control the important things in your life?” and “how often have you felt nervous or stressed?” The response options are on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The α reliability was 0.85.

### 2.2.4. Alcohol use (quantity/frequency measure)
We combined the quantity and frequency items into a single scale by converting the frequency levels into equivalent occasions per month, which ranged from 1 = 0.5 times per month to 7 = 28 times per month, and the quantity levels into equivalent grams of alcohol, which ranged from 1 = 10 g a month to 5 = 70 g a month. Next, these values were then multiplied, and the distribution of scores were log_{10} transformed (Wood et al., 1992).

### 2.2.5. The young adult alcohol problems screening test
The YAAPST (Hurlbut & Sher, 1992) is a 27-item scale designed to measure the frequency of problematic alcohol usage in college students during the past year. The scale includes questions such as “Have you ever driven a car when you knew you had too much to drink to drive safely?” The 10 response options range from 0 (No, never) to 9 (40 or more times in the past year). The α reliability was 0.89.

### 2.3. Statistical analysis
A structural equation model was fit with Mplus v8.3 (Muthen & Muthen, 1998–2017) to evaluate our conceptual model displayed in Fig. 1. Comparative fit index (CFI; Bentler, 1990), Root Mean Square Error of Approximation analyses (RMSEA; Browne & Cudeck, 1993; Hu & Bentler, 1998), and χ² statistics were used to determine model fit. The direct and indirect effects between childhood loneliness, stress, impaired-control-over-drinking, and alcohol problems were assessed using mediation analyses, such as the bias corrected bootstrap technique (k = 20,000; Efron & Tibshirani, 1993) and 95% confidence intervals around the estimates (Hancock & Liu, 2012, MacKinnon, 2008; Tofghi & MacKinnon, 2011). We also examined our model with both the ML (maximum likelihood) as well as the MLR estimator. Bentler (1983) suggested the MLR estimator for normally distributed outcome variables in path models. We coded women as zeros and men as ones in our model for the sake of interpretation of the gender effects. Table 1 presents the means, standard deviations, and correlations among all the variables in the model tested (see Fig. 2.).

### 3. Results
The model fit indices yielded χ² (2 df) = 0.297, p = 0.862; RMSEA = 0.00; 90% CI (0.00, 0.059); probability of RMSEA < = 0.05 = 0.933; CFI = 1.00; TLI = 1.042. The only difference we noticed between using ML and MLR estimators was that the TLI index dropped from 1.042 to 1.000; beta weights and significant relationships remained the same.

#### 3.1. Indirect effects

##### 3.1.1. Impaired control over drinking (IC)
Higher levels of loneliness as a child were indirectly linked to more IC through more stress [indirect effect = 0.100, S.E. = 0.026, Z = 3.816, p < .001, 95% CI (0.052, 0.155)]. Being male was indirectly linked to less IC through less stress experienced [indirect effect = -0.051, S.E. = 0.022, Z = -2.254, p = 0.024, 95% CI (-0.099, -0.012)]. Therefore, being female was indirectly linked to more IC through more stress.

##### 3.1.2. Alcohol use (quantity/frequency)
Higher levels of loneliness as a child were indirectly linked to more alcohol use through increased stress, and in turn, more IC [indirect effect = 0.024, S.E. = 0.009, Z = 2.836, p = 0.005, 95% CI (0.010, 0.043)]. Additionally, being male was indirectly linked to less alcohol use through less stress, and in turn, less IC [indirect effect = -0.012, S.E. = 0.006, Z = -1.997, p = 0.046, 95% CI (-0.026, -0.002)]. Conversely, being female was indirectly linked to more alcohol use through increased stress, and in turn, more IC.

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![Fig. 1. Conceptual model for all examined paths among the variables in the model.](image-url)
literature which links adverse childhood experience to problematic
related problems. Perceived stress mediated the indirect link between
of the mechanisms by which loneliness indirectly predicts alcohol-
over-alcohol (IC), alcohol use, and alcohol-related problems. We add
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lonely individuals tend to drink more (Mckay et al., 2017; Pursor, 2020),
sel-regulation to IC. Albeit some previous research has shown that
findings are consistent with previous evaluative stressor was used (Patock-Peckham et al., 2022). The present
findings are better able to characterize the positive association between
liness heightens cognitive, emotional, and neurophysiological dysregu-
 diagnosed alcohol-related problems not sufficient evidence that there were extreme scores present in our sample. Furthermore, when the MLR estimator
was utilized [as suggested by Bentler (1983) using the Santorra-Bentler Chi-Square for non-normally distributed variables] instead of the ML default we observed no
meaningful changes to our model or model interpretation.

Fig. 2. Fit path model for 310 participants. Standardized coefficients are shown for all participants and Z scores are in the model; * p < .05; ** p < .01; *** p < .001.

3.1.3. Alcohol-related problems
Higher levels of loneliness as a child were indirectly linked to more
alcohol-related problems through more stress, and in turn, more IC
[indirect effect = 0.042, S.E. = 0.013, Z = 3.150, p = .002, 95% CI
(0.020, 0.072)]. Being male was indirectly linked to less alcohol-related
problems through less stress, and in turn, less IC [indirect effect = −0.021,
S.E. = 0.010, Z = −2.087, p = 0.037, 95% CI (−0.045, −0.005)].
Therefore, being female was indirectly linked to more alcohol-related
problems through more stress, and in turn, more impaired-control-
over-drinking.

4. Discussion
Cacioppo’s Evolutionary Theory (2006) suggests that lonely
individuates have deficits in execute functioning, impulsivity control, as
well as experience more physical pain (Cacioppo et al., 2009; Bau-
meister et al., 2005). This study presents novel insights towards child-
hood loneliness direct and indirect associations with impaired-control-
over-alcohol (IC), alcohol use, and alcohol-related problems. We add
the to existing literature by extending loneliness-related problems in
self-regulation to IC. Albeit some previous research has shown that
lonely individuals tend to drink more (Nckay et al., 2017; Pursor, 2020),
evidence has been inconsistent (Cacioppo et al., 2002; Chen & Feeley,
2015). Our study helps reconcile these inconsistencies by finding some
of the mechanisms by which loneliness indirectly predicts alcohol-
related problems. Perceived stress mediated the indirect link between
childhood loneliness and IC. Our findings are consistent with previous
literature which links adverse childhood experience to problematic
drinking outcomes in emerging adulthood (Kendall-Tackett, 2002; Rothman et al., 2008), but are also novel as they present a stress
mediated pathway by which childhood loneliness results in dysregu-
lated drinking.

This is the first study to show mechanisms of IC in the context of
loneliness. Childhood loneliness was indirectly and positively associated
with IC through increased perceived stress. Our findings are consistent
with Fox et al. (2010) who suggested that impulsivity and stress increase problematic alcohol use. Strickland & Johnson (2021) suggest that
rather than using a global impulsivity construct to use the context
associated with each behavioral decision. Impaired control considers the
decision specific to the drinking context (Patock-Peckham & colleagues
2001; 2006; 2011; 2018; 2020; 2022). Similar to other studies, IC was
associated with an increase in quantity and in frequency of alcohol
consumption as well as alcohol-related problems (Frohe et al., 2020;
Noudali et al., 2022; Patock-Peckham et al., 2020). The Theory of
Loneliness (Cacioppo et al., 2006) suggests that, when sustained, lone-
liness heightens cognitive, emotional, and neurophysiological dysregu-
lation, and our study extends these implications to the dysregulation of
drinking as well.

Our study supports the Stress Dampening Theory (Marlatt, 1987; Sher, 1987), which posits that alcohol functions as a self-regulatory
mechanism used to relieve negative affect. Consistent with Ayer et al.
(2011), we found perceived stress was related to more problematic
drinking outcomes especially among women. This is also consistent with
recent alcohol self-administration studies in which an acute social
evaluative stressor was used (Patock-Peckham et al., 2022). The present
findings are better able to characterize the positive association between
stress and alcohol consumption. Individuals who had lonely
childhoods are more reactive to stress (Nowland et al., 2018; Brown et al., 2018) and may not have learned appropriate coping mechanisms (Qualter et al., 2009). This pattern of relationships was more pronounced among

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**Table 1**

| Measures            | 1  | 2  | 3  | 4  | 5  | 6  |
|---------------------|----|----|----|----|----|----|
| Loneliness          | 1.00 |    |    |    |    |    |
| Stress              | 2.00 |    |    |    |    |    |
| Impaired Control    | 0.00 |    |    |    |    |    |
| Alcohol-Related Problems | 0.00 |    |    |    |    |    |

**Notes:**
- M: Mean, SD: Standard Deviation, Range: Range, Skew: Skew, Kurtosis: Kurtosis, Measures: Number of measures.
- N = 310. Please note that 85.5% of our sample identified themselves as current drinkers of alcoholic beverages. According to Brown (2006) skew of −3 and 3 and kurtosis of −3 and 3 are acceptable for SEM models. Thus, our kurtosis for alcohol-related problems is slightly elevated here likely due to the large numbers of individuals in our college sample identifying as a current drinker and all individuals in the sample endorsing at least one alcohol consequence experienced by age 19. However, a range from (1.00, 6.00) alcohol-related problems is not sufficient evidence that there were extreme scores present in our sample. Furthermore, when the MLR estimator was utilized [as suggested by Bentler (1983) using the Santorra-Bentler Chi-Square for non-normally distributed variables] instead of the ML default we observed no meaningful changes to our model or model interpretation.
women. Therefore, our model shows how dysregulated alcohol consumption may be used to reduce perceived stress particularly among the lonely.

Our study examined how childhood loneliness predicts increased stress in emerging adulthood, and the pathway by which alcohol is misused to alleviate that stress. In tandem, we found that greater childhood loneliness predicted greater perceived stress among emerging adults. Additionally, we found that women reported greater levels of loneliness throughout the stages of development (Vanhalst et al., 2018). Consistent with the Stress Dampening Theory (Marlatt, 1987; Sayette, 1993; Sher, 1987), stress mediated the pathway to IC, and in turn, alcohol-related problems. Our loneliness model provides novel mechanisms by which childhood loneliness prior to the age of 12 predicts alcohol misuse through the stress to the impaired control pathway.

4.1. Limitations

Despite our study’s novel finding(s) regarding childhood loneliness and drinking outcomes, it has several limitations. One limitation to this study was the retrospective nature of self-reported childhood loneliness. Although retrospective reports of childhood adversity are generally reliable, such accounts are subject to recall bias (Hardt & Rutter, 2004). The study was also cross-sectional and could only show exploratory associations. Because of the differences between the effects of momentary and enduring loneliness, future research should measure loneliness longitudinally. Additionally, due to the variability in the trajectories of loneliness throughout the stages of development (Vanhalst et al., 2018), the occurrence and the effects of loneliness may not have been limited to childhood. Therefore, measuring loneliness at multiple time points would be a logical next step. Next, the relationship between stress and loneliness could be bidirectional (Doane & Thurston, 2014) and our model only addresses a loneliness to stress direction. It would also be prudent to replicate these findings with a more normally distributed measure of alcohol-related problems than what we utilized here. Moreover, the Stress Dampening Theory (Marlatt, 1987; Sayette, 1993; Sher, 1987) of alcohol consumption inspired our study, yet we did not include measurements of drinking motives (Cooper et al., 1992a; 1992b). Future studies should include drinking motives.

4.2. Conclusions

Our study provides novel evidence for the Stress Dampening Hypothesis (Marlatt, 1987; Sher, 1987) implicating childhood loneliness as a direct and indirect predictor of alcohol-related problems. Higher levels of loneliness in childhood prior to age 12 directly predicted alcohol-related problems in emerging adulthood and indirectly predicted greater dysregulated alcohol consumption through a perceived stress pathway. Through stress, childhood loneliness predicted more impaired-control-over-drinking. Impaired control has longitudinally predicted AUD in previous studies (Leeman et al., 2009; Patock-Peckham et al., 2019) as well as problematic drinking outcomes. Therefore, our model has clinical implications. Intervening in childhood loneliness could prove useful in inhibiting the pathway to emerging adulthood alcohol misuse. Childhood interventions that target social and emotional regulation skills have been effective in preventing transient loneliness from becoming debilitating and chronic (Eccles & Quilter, 2020; Quilter et al., 2015). Our study presents novel evidence for a stress-mediated pathway between childhood loneliness and dysregulated alcohol use. The findings suggest that perceived stress is an important target of intervention for those with AUDs, especially among women.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. However, Dr. William Corbin should not be asked to review this manuscript because he has served as a mentor to the second author on her K01 grant.

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