



Relations among protective behavioral strategies, biological sex, and ADHD symptoms on alcohol use and related problems: Who benefits most, and from what type of strategy?

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ABSTRACT

Attention-deficit/hyperactivity disorder (ADHD) symptoms among college students are associated with high rates of alcohol use and alcohol-related consequences. Use of protective behavioral strategies (PBS) is generally related to lower levels of alcohol use and problems; however, it is unclear how effectively students with ADHD symptoms can implement PBS, and whether certain types of PBS use may yield better outcomes. This study examined relations between PBS type and ADHD symptoms on both alcohol use and consequences, and whether these relations varied by biological sex. Participants were 875 college student drinkers from three universities who completed measures of ADHD symptoms, PBS, past-month alcohol use, and alcohol-related consequences. There were significant moderation effects of ADHD symptoms, such that the relation between PBS use and alcohol use was more pronounced for students high in inattention, and the relation between PBS use and alcohol-related consequences was more pronounced for students high in either inattention or hyperactivity/impulsivity symptoms. These relations were found for both manner of drinking and stopping/limiting drinking PBS, and they tended to be strongest for male students. There were no significant interaction effects that included serious harm reduction PBS; for all students, increased use of this type of PBS was associated with fewer problems. These results suggest that PBS are likely effective for students with ADHD symptoms. Interventions that provide explicit instruction in employing PBS, particularly related to manner of drinking and stopping/limiting drinking strategies, are recommended for students with ADHD symptoms.

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder that can persist through childhood and into adulthood. ADHD includes symptoms of inattention (e.g., being easily distracted, forgetful) and/or symptoms of hyperactivity/impulsivity (e.g., fidgets, interrupts). ADHD symptoms are associated with increased alcohol use and alcohol-related problems, especially among college students (Blase et al., 2009; Glass & Flory, 2012; Mesman, 2015; Rooney, Chronis-Tuscano, & Yoon, 2012). These relations are found using varied measures of ADHD symptomatology, including self- and parent-report of current and retrospective symptom counts, diagnostic labels,

and measures of impairment. Informed by multiple methodologies and measures of ADHD symptoms, college students with, or at-risk for, ADHD are clearly in need of intervention strategies to reduce alcohol use and related problems.

Protective behavioral strategies (PBS) are an increasingly popular approach to reducing problematic drinking among college students. PBS involve active behavioral techniques applied before, during, and after alcohol consumption to reduce or eliminate use and related consequences (Prince, Carey, & Maisto, 2013). PBS are categorized into three domains (Martens et al., 2005): serious harm reduction (SHR; i.e., strategies related to avoiding very serious consequences), stopping/limiting drinking (SLD; i.e., strategies related to slowing or stopping

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drinking), and manner of drinking (MOD; i.e., strategies related to reducing risky consumption behaviors). Substantial research supports a negative relation between PBS use and alcohol consumption and related consequences (e.g., Pearson, 2013). However, type of PBS appears differentially related to outcome: serious harm reduction PBS are associated with fewer problems but not necessarily quantity of use, manner of drinking PBS are negatively associated with both use and consequences (Napper, Kenney, Lac, Lewis, & LaBrie, 2014), and there are mixed findings pertaining to stopping/limiting drinking strategies (Frank, Thake, & Davis, 2012; Napper et al., 2014). Regarding demographic moderators, women are more likely than men to effectively use PBS (LaBrie, Lac, Kenney, & Mirza, 2011; Pearson, 2013), particularly serious harm reduction strategies (Clarke et al., 2016; Taberner, Gutiérrez-Domingo, Luque, García-Vázquez, & Cuadrado, 2019). Further, individuals with mental health problems (LaBrie, Kenney, Lac, García, & Ferraiolo, 2009) and those with poor self-regulation abilities (D'Lima, Pearson, & Kelley, 2012) may uniquely benefit from PBS use. It stands to reason that similar protective benefits of PBS may be evidenced in students with ADHD symptoms, who are at-risk for alcohol-related problems (Glass & Flory, 2012) and experience self-regulation difficulties (Shiels & Hawk, 2010).

Yet, PBS use among students with ADHD symptoms is understudied. Given that PBS utilization requires the ability to plan and follow through with intentions, it is possible that ADHD symptoms that interfere with self-regulation and impulse control may disrupt PBS implementation. However, it is also possible that since these strategies are relatively straightforward and simple, they may in fact be easily employed by individuals with ADHD symptoms. Only two studies to date have examined PBS use among college students with ADHD symptoms, yielding mixed findings. Howard and Pritchard (2017) found no differences in PBS use between students with and without ADHD, and no moderation effect of ADHD diagnosis on the relation between PBS and alcohol use or consequences. This study examined ADHD diagnostically, rather than via continuous symptom measures, as students with a current ADHD diagnosis were recruited via a student disability office. However, serious harm reduction PBS were not included in analyses, and the effect of sex was not considered. In contrast, a study examining current ADHD symptoms continuously via self-report found both sex and ADHD symptoms to moderate the relation between PBS and alcohol use in students referred to an alcohol awareness program (Looby, Cleveland, Zimmerman, & Hartung, 2019). Specifically, the relation between PBS use and alcohol was most pronounced in women high in hyperactivity/impulsivity. Limitations included that neither PBS type, nor alcohol-related consequences, were assessed. Nevertheless, initial evidence that female college students with ADHD symptoms may be particularly at-risk for heavy alcohol use if not frequently using PBS is concerning and warrants further examination.

The current study examined the moderating effect of ADHD symptoms on the relation between PBS type and both alcohol use and related consequences among a large, multisite sample of college student drinkers. We examined ADHD symptom dimensions (i.e., inattention, hyperactivity/impulsivity) separately, following evidence that they are considered distinct constructs (Willcutt et al., 2012) and that they differentially relate to PBS and alcohol use (Looby et al., 2019). Given sex/gender differences that exist for ADHD prevalence rates and symptom expression (Hartung & Lefler, 2019), alcohol use (Engs & Hanson, 1990), and PBS use (Pearson, 2013), we examined biological sex as an additional moderator of these relations. We hypothesized stronger moderation effects of ADHD symptoms on the relation between PBS and alcohol use and consequences for female college students, particularly those high in hyperactivity/impulsivity. We did not posit a priori hypotheses about differential associations by PBS domain.

2. Method

2.1. Participants and procedures

Data for the current study were collected as part of an ongoing multisite study of ADHD in college. Undergraduate students ($N = 1,537$) completed an online survey via Psychology Department participant pools at three universities located in the Rocky Mountain West, the Midwest, and the Mid-Atlantic regions of the U.S. during the 2018–2019 academic year. After providing informed consent, participants completed a large battery of measures on demographics, ADHD, substance use, and related constructs. Only measures relevant to the current study are described herein. Participants received research credit for a psychology course for completing the survey, which was approved by each participating university's Institutional Review Board.

The present analytic sample was limited to 875 participants (68.5% biological female) who were between the ages of 18–25 years ($M = 19.36$, $SD = 1.45$), were past-month alcohol users, and reported on their biological sex, ADHD symptoms, alcohol use and related problems, and PBS use. Among excluded respondents, 24 were outside the target age range, 606 denied past-month alcohol use, and 32 failed to complete a key measure. Most participants were white (87.1%), followed by Hispanic/Latino (4.6%), mixed race (2.5%), Asian/Pacific Islander (2.4%), Black (2.2%), and American Indian (0.7%), with 0.6% not responding.

2.2. Measures

2.2.1. Demographics

A demographics form included items on age, race, and biological sex (clearly differentiated from an item on gender identity).

2.2.2. Daily Drinking Questionnaire

Typical weekly alcohol use was assessed via a modified version of the Daily Drinking Questionnaire (Collins, Parks, & Marlatt, 1985). Participants reported how much they drank during a typical week in the past month using a 7-day grid from Monday to Sunday. Number of standard drinks consumed on each day of the typical drinking week were summed.

2.2.3. Alcohol-related problems

Past-month alcohol-related problems were assessed via a modified version of the Rutgers Alcohol Problems Index (RAPI; White & Labouvie, 1989). The original RAPI assesses how frequently participants experienced 23 alcohol-related consequences. The present study utilized a modified version including two additional items (i.e., "I drove after having two drinks" and "I drove after having four drinks"; Neighbors, Lewis, Bergstrom, & Larimer, 2006). Frequency of experiencing each consequence was assessed on a 4-point scale (0 = none to 3 = more than 5 times). Item scores were summed ($\alpha = 0.92$).

2.2.4. Alcohol Protective Behavioral Strategies

Alcohol-related PBS use was assessed via the 20-item Protective Behavioral Strategies Scale-20 (Treloar, Martens, & McCarthy, 2015). Frequency of past-month PBS use was assessed on a 6-point scale (1 = never to 6 = always), measuring three domains of PBS use: serious harm reduction (SHR; e.g., "use a designated driver"; 8 items, $\alpha = 0.87$), stopping/limiting drinking (SLD; e.g., "stop drinking at a predetermined time"; 7 items, $\alpha = 0.88$), and manner of drinking (MOD; e.g., "avoid drinking games"; 5 items, $\alpha = 0.86$). Scores on items related to each PBS domain were summed and averaged.

2.2.5. ADHD symptoms

The DSM-5 ADHD Symptoms Checklist assessed past-six-month ADHD symptoms. Questions on the 18-item measure are based on phrasing of the ADHD symptoms in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; American Psychiatric Association, 2013),

and ask participants to indicate how frequently each symptom is experienced when not taking ADHD medication. Items are rated on a 4-point scale (0 = never to 3 = very often) and assess symptoms of inattention (9 items, e.g., “Fail to give close attention to details or make careless mistakes in schoolwork, at work, or during other activities (e.g., overlook or miss details, or work is inaccurate)”); $\alpha = 0.93$) and hyperactivity/impulsivity (9 items, e.g., “Have difficulty waiting for my turn (e.g., while waiting in line)”); $\alpha = 0.88$). Severity scores for each symptom cluster were summed.

2.3. Data analytic plan

Alcohol use and problems variables are known to be highly skewed and over dispersed, often with a preponderance of zeros (Atkins & Gallop, 2007). In the present sample, both variables were positively skewed (drinks = 1.64, problems = 2.22), and 33% of the sample endorsed zero problems. Thus, we used zero inflated negative binomial (ZINB) regressions to model alcohol-related problems and quasi-Poisson (QP) regressions for alcohol use (which did not contain any zeros). ZINB models are two-part models: the count portion of the model predicts the value of the outcome among those with a non-zero value, and the logistic portion predicts the likelihood of endorsing 0 vs. non-0. QP regression models outperform other approaches to modeling highly skewed over dispersed count data in the addiction field (Baggio, Iglesias, & Rousson, 2018). Both ZINB and QP regression models use a log link function; therefore, logits can be exponentiated to calculate rate ratios (RRs) for ease of interpretation. RRs are interpreted as the percent change in the count outcome predicted from a one-unit change in the predictor. Similarly, for the logistic portion of the ZINB models, exponentiated logits become odds ratios (ORs), which are interpreted as the change in the likelihood of endorsing a non-0 value over a 0 value for a unit change in the predictor. Data were analyzed using the statistical software R (R Core Team, 2020). ZINB regression models were run using the *pscl*

package (Zeileis, Kleiber, & Jackman, 2008), and QP regression models were run using the *MASS* package (Venables & Ripley, 2002).

Regression models evaluating three-way interactions (ADHD symptom \times PBS type \times sex) were conducted separately for ADHD symptom clusters and for PBS domains; thus, six models were conducted for each outcome variable (i.e., weekly drinks, alcohol-related problems). In the alcohol-related problems models, weekly drinks were controlled when predicting the logistic portion of the ZINB models. Models specifying a particular ADHD symptom cluster and PBS domain controlled for levels of the other symptom cluster and domains. In cases where the three-way interaction term was not significant, the model was re-specified without sex as a predictor variable, and the ADHD symptom \times PBS domain interaction was examined. Two-way interactions including sex were not examined because these were not the current focus of study. Given the large sample size and relatively large number of statistical tests, significance was determined via 99% CIs of the RRs or ORs that did not include 1.

3. Results

Prior to analysis, 26 participants were removed because their typical weekly drinking scores ($n = 13$) or their RAPI scores ($n = 13$) were determined to be outliers (i.e., standardized scores >3.29 ; Tabachnick & Fidell, 2007). Descriptive statistics and correlations are provided for all study variables in Table 1. Participants reported approximately 8 drinks weekly, though there was wide variability (range: 1–36). ADHD symptom scores were low, though comparable to other research on ADHD symptoms and PBS use (Looby et al., 2019). Approximately 11% of subjects reported lifetime diagnosis of ADHD by a treatment provider; of those, 85.6% reported initial diagnosis in childhood or adolescence. Correlations among variables were generally in the expected directions. All PBS domains were significantly positively correlated with one another, and significantly negatively correlated with alcohol use and

Table 1
Bivariate correlations and descriptive statistics among all study variables ($N = 849$).

	1	2	3	4	5	6	7	8	M	SD
1. Sex	–								1.69	0.46
2. Inattention Symptoms	0.05	–							5.71	6.02
3. Hyperactivity/Impulsivity Symptoms	0.02	0.76	–						4.00	4.64
4. Serious Harm Reduction PBS	0.29	–0.05	–0.09	–					5.02	1.09
5. Limiting/Stopping Drinking PBS	0.19	–0.04	–0.05	0.57	–				3.48	1.37
6. Manner of Drinking PBS	0.15	–0.08	–0.11	0.56	0.76	–			3.41	1.40
7. Weekly Drinks	– 0.27	0.07	0.09	– 0.24	– 0.34	– 0.42	–		7.95	6.50
8. Alcohol-Related Problems	0.02	0.26	0.33	– 0.20	– 0.16	– 0.25	0.37	–	3.55	4.91

Note. Sex was coded 1 = male, 2 = female. Significant correlations at $p < .001$ are in bold typeface for emphasis. PBS = Protective Behavioral Strategies.

Table 2
Quasi-Poisson Regression models of the interactions among PBS type, ADHD symptoms, and sex on alcohol use.

Variable	RR					
	99% CI					
Constant	16.93 (16.58, 17.29)	15.47 (15.18, 15.76)	15.69 (15.40, 15.97)	17.06 (16.73, 17.39)	16.17 (15.88, 16.46)	15.95 (15.67, 16.24)
Sex	0.68 (0.51, 0.86)	0.67 (0.50, 0.84)	0.66 (0.49, 0.82)	0.70 (0.53, 0.87)	0.69 (0.53, 0.86)	0.68 (0.51, 0.84)
IN Symptoms	1.00 (0.95, 1.05)	1.02 (0.99, 1.05)	1.02 (0.99, 1.05)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)
H/I Symptoms	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	1.00 (0.95, 1.05)	1.02 (0.98, 1.05)	1.02 (0.99, 1.05)
SHR PBS	1.06 (0.98, 1.14)	1.06 (1.00, 1.13)	1.06 (1.00, 1.13)	1.06 (0.98, 1.14)	1.06 (1.00, 1.13)	1.06 (1.00, 1.13)
SLD PBS	0.97 (0.90, 1.04)	1.00 (0.92, 1.09)	0.97 (0.90, 1.04)	0.97 (0.90, 1.04)	0.98 (0.90, 1.06)	0.97 (0.90, 1.04)
MOD PBS	0.79 (0.72, 0.86)	0.79 (0.86, 1.02)	0.82 (0.73, 0.90)	0.79 (0.72, 0.86)	0.79 (0.72, 0.86)	0.80 (0.72, 0.88)
SHR \times IN \times Sex	1.00 (0.99, 1.01)					
SLD \times IN \times Sex		0.99 (0.98, 1.00)				
MOD \times IN \times Sex			0.99 (0.98, 1.00)			
SHR \times H/I \times Sex				1.00 (0.99, 1.01)		
SLD \times H/I \times Sex					1.00 (0.99, 1.01)	
MOD \times H/I \times Sex						0.99 (0.98, 1.00)

Note. Significant results are bolded and were determined via 99% CIs for the Rate Ratios that did not contain 1. Biological sex was coded as 1 = male, 2 = female. PBS = Protective Behavioral Strategies. SHR = Serious Harm Reduction. SLD = Stopping/Limiting Drinking. MOD = Manner of Drinking. IN = Inattentive symptoms. H/I = Hyperactive/Impulsive Symptoms. RR = Rate Ratio.

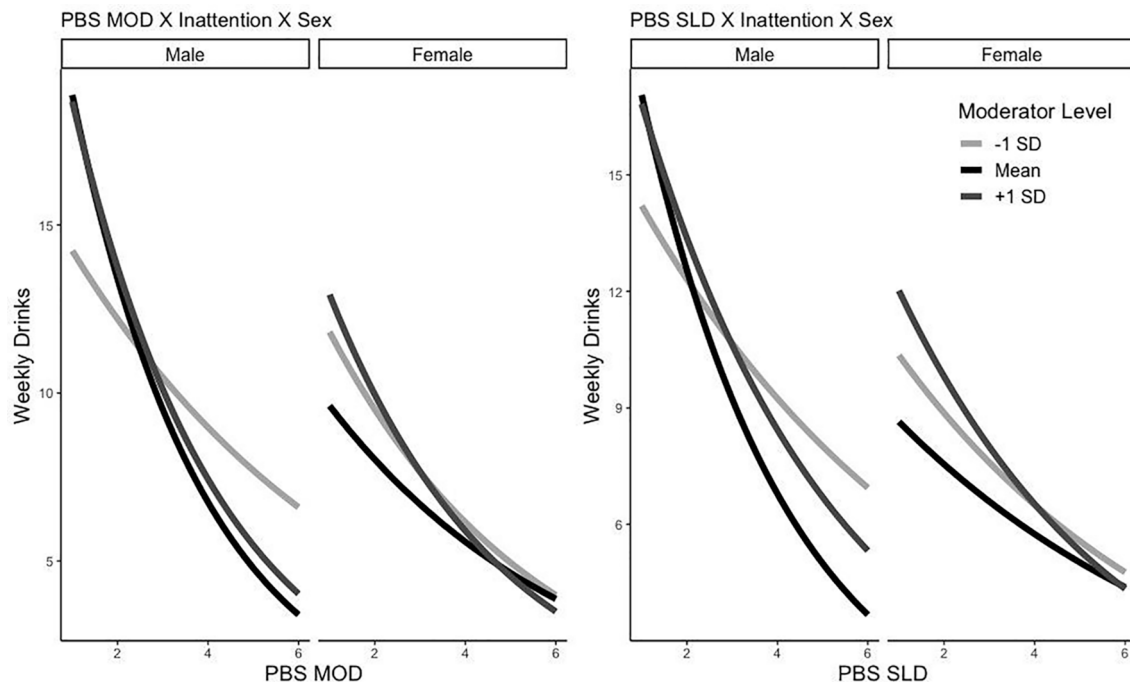


Fig. 1. Interaction Effects of PBS Type, ADHD Symptom Type, and Sex on Weekly Drinks Note. The left panel depicts simple slopes of the Manner of Drinking PBS × Inattention Symptoms × Sex interaction on weekly drinks. The right panel depicts simple slopes of the Stopping/Limiting Drinking PBS × Inattention Symptoms × Sex interaction on weekly drinks. PBS = Protective Behavioral Strategies. MOD = Manner of Drinking. SLD = Stopping/Limiting Drinking.

problems. ADHD symptoms were significantly positively correlated with one another, and with alcohol-related problems; however, neither ADHD symptom cluster was significantly associated with alcohol use. Neither ADHD symptom cluster was significantly associated with any domain of PBS use. Female sex was significantly associated with greater frequency of use of all PBS types, and negatively correlated with alcohol use. However, there were no significant relations between sex and alcohol-related problems.

Six QP regressions were conducted to examine three-way interactions among PBS type (i.e., SHR, SLD, MOD), ADHD symptom dimension (i.e., inattention, hyperactivity/impulsivity), and sex on typical weekly drinks (see Table 2). Two significant 3-way interactions were identified: SLD PBS × Inattention × Sex, and MOD PBS × Inattention × Sex. Plots of the simple slopes are presented in Fig. 1. For those

with higher inattention symptoms, there was a stronger negative relation between both SLD and MOD PBS use and weekly drinks, and these effects were stronger for males. There were no significant 3-way or 2-way interactions for SHR strategies or hyperactivity/impulsivity symptoms when predicting weekly drinks. The direct effects were inconsistently significant for SHR PBS, but the rate ratio consistently predicted a 6% increase in alcohol use for a 1-unit increase in SHR PBS. The direct effects were not significant for hyperactivity/impulsivity.

Six ZINB regressions were conducted to examine three-way interactions among PBS type, ADHD symptom cluster, and sex on RAPI score (see Table 3). There were two significant 3-way interactions: SLD PBS × Inattention × Sex, and MOD PBS × Inattention × Sex. In addition, the 3-way interaction between SLD PBS × Hyperactivity/Impulsivity × Sex was significant with females as the referent group (RR = 1.01, 99%

Table 3

Zero inflated negative binomial regression models of the interactions among PBS type, ADHD symptoms, and sex on alcohol-related problems.

Variable	RR					
	99% CI					
Constant	3.51 (2.56, 4.46)	5.67 (4.94, 6.40)	5.27 (4.55, 6.00)	4.49 (3.58, 5.39)	6.82 (6.09, 7.56)	6.24 (5.53, 6.96)
Sex	1.79 (1.44, 2.13)	1.82 (1.48, 2.16)	1.84 (1.52, 2.17)	1.51 (1.17, 1.85)	1.53 (1.21, 1.86)	1.58 (1.27, 1.89)
IN Symptoms	1.05 (0.94, 1.15)	0.98 (0.92, 1.03)	0.98 (0.94, 1.03)	1.00 (0.98, 1.03)	1.00 (0.97, 1.03)	1.00 (0.97, 1.03)
H/I Symptoms	1.07 (1.04, 1.10)	1.07 (1.03, 1.10)	1.07 (1.03, 1.10)	1.11 (0.98, 1.24)	1.02 (0.94, 1.09)	1.03 (0.96, 1.09)
SHR PBS	0.85 (0.66, 1.04)	0.79 (0.66, 0.93)	0.80 (0.66, 0.93)	0.83 (0.65, 1.01)	0.79 (0.66, 0.93)	0.80 (0.66, 0.93)
SLD PBS	1.05 (0.92, 1.17)	1.00 (0.86, 1.15)	1.05 (0.92, 1.17)	1.04 (0.91, 1.16)	0.99 (0.85, 1.13)	1.04 (0.91, 1.17)
MOD PBS	0.91 (0.78, 1.04)	0.91 (0.78, 1.04)	0.88 (0.73, 1.03)	0.92 (0.79, 1.05)	0.91 (0.78, 1.04)	0.87 (0.72, 1.02)
SHR × IN × Sex	1.00 (0.97, 1.02)					
SLD × IN × Sex		1.02 (1.00, 1.04)				
MOD × IN × Sex			1.01 (1.00, 1.03)			
SHR × H/I × Sex				0.99 (0.96, 1.02)		
SLD × H/I × Sex					1.02 (0.99, 1.04)	
MOD × H/I × Sex						1.01 (0.99, 1.04)
	OR					
	99% CI					
Weekly Drinks	0.82 (0.67, 0.96)	0.82 (0.67, 0.97)	0.81 (0.66, 0.97)	0.81 (0.67, 0.96)	0.81 (0.64, 0.98)	0.81 (0.64, 0.74)

Note. Significant results are bolded and were determined via 99% CIs for the Rate Ratios and Odds Ratios that did not contain 1. Biological sex was coded as 1 = male, 2 = female. PBS = Protective Behavioral Strategies. SHR = Serious Harm Reduction. SLD = Stopping/Limiting Drinking. MOD = Manner of Drinking. IN = Inattentive symptoms. H/I = Hyperactive/Impulsive Symptoms. RR = Rate Ratio. OR = Odds Ratio.

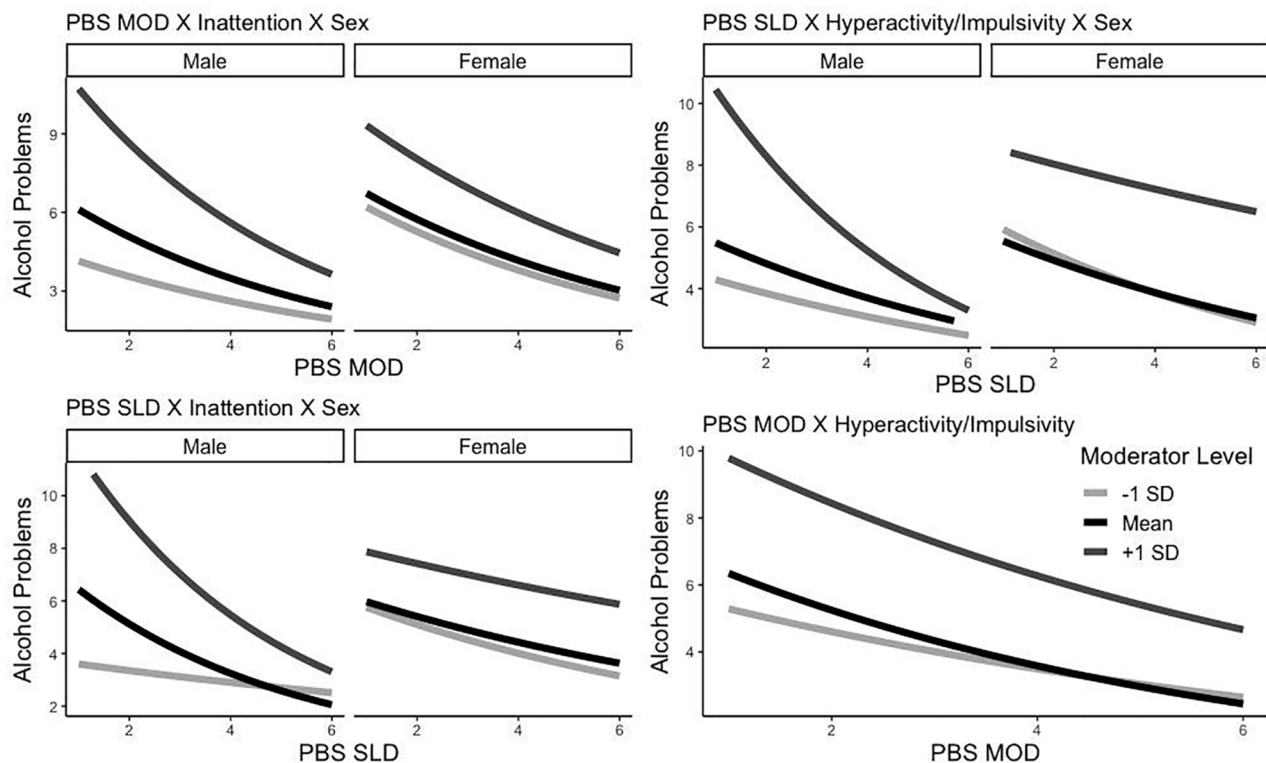


Fig. 2. Interaction Effects of PBS Type, ADHD Symptom Type, and Sex on Alcohol-Related Problems. Note. The top left panel depicts simple slopes of the Manner of Drinking PBS \times Inattention Symptoms \times Sex interaction on alcohol-related problems. The bottom left panel depicts simple slopes of the Stopping/Limiting Drinking PBS \times Inattention Symptoms \times Sex interaction on alcohol-related problems. The top right panel depicts simple slopes of the Stopping/Limiting Drinking PBS \times Hyperactivity/Impulsivity Symptoms \times Sex interaction on alcohol-related problems. The bottom right panel depicts simple slopes of the Manner of Drinking PBS \times Hyperactivity/Impulsivity symptoms interaction on alcohol-related problems. PBS = Protective Behavioral Strategies. MOD = Manner of Drinking. SLD = Stopping/Limiting Drinking.

CI: 1.00, 1.03), but not males (RR = 1.02, 99% CI: 0.99, 1.04); however, the effects were similar in magnitude and in the same direction. Moreover, there was one significant 2-way interaction: MOD PBS \times Hyperactivity/Impulsivity (RR = 1.02, 99% CI: 1.00, 1.03). Fig. 2 displays simple slopes for these significant interactions. The logistic portion suggested that for each additional drink per week, participants were 1.25 times more likely to endorse any alcohol-related problems. Interpretations of the significant 2- and 3-way interactions suggest that those who are higher in either type of ADHD symptoms had a stronger negative relation between SLD and MOD PBS and alcohol-related problems, and that the effects tended to be more pronounced for males, particularly those high in inattention. There were no significant interactions including SHR PBS, but the direct effects indicated that for each additional unit of SHR PBS use frequency, participants reported between 7% and 16% fewer consequences.

4. Discussion

These results add to the literature demonstrating that PBS can be effectively used by students with mental health problems, expanding this to ADHD symptoms. This is important given evidence that undergraduates with ADHD symptoms experience significant alcohol-related impairment (Mesman, 2015), and the present results indicating greater alcohol use and problems among students reporting elevated ADHD symptoms but infrequent PBS use. Though our hypothesized results of stronger relations between PBS and alcohol use and problems among female students high in hyperactivity/impulsivity were not supported, a separate pattern of results emerged that has important implications for alcohol interventions among students with ADHD symptoms.

Specifically, we found two PBS domains (i.e., manner of drinking,

stopping/limiting drinking) to interact with inattention symptoms and sex in the association with alcohol use. Male students high in inattention who reported infrequent PBS use reported the highest weekly drinks; however, weekly drinks were comparable among all students regardless of inattention symptom severity when PBS were frequently employed. Further, manner of drinking and stopping/limiting drinking PBS interacted with both ADHD symptom dimensions to relate to alcohol-related problems, with sex as an additional moderator in most models such that effects again were most pronounced for male students. There were no significant interactions involving serious harm reduction PBS on either outcome variable. Importantly, across the sample, increased serious harm reduction PBS use was associated with fewer problems. This may reflect increased saliency and general promotion of these types of strategies across all college students (e.g., using a designated driver), or that these strategies tend not to necessitate high levels of active monitoring present in manner of drinking (e.g., drink slowly) and stopping/limiting drinking (e.g., stop drinking at a predetermined time) strategies, which may be more difficult for students experiencing greater ADHD symptomatology to effectively employ.

That the relations between PBS use and alcohol-related constructs were strongest for male students was surprising in the context of research finding that women report more effective PBS use (Pearson, 2013). Yet, research considering mental health symptoms as additional moderators of this relation yields more inconsistent results. For example, Jordan, Madson, Nicholson, Bravo, and Pearson (2019) found the relation between PTSD symptoms and alcohol-related problems to be attenuated with frequent PBS use, but only for women. In contrast, Kenney and LaBrie (2013) found that Asian men experiencing poorer mental health garnered unique benefit from PBS use. Similarly, Grazioli et al. (2021) found a stronger negative association between PBS and alcohol use in men with borderline personality disorder than in men

without; however, this same relation was not found for other psychopathologies. Taken together, PBS use may differentially impact emerging adults depending on mental health symptomatology and sex/gender, with the present results suggesting that male students higher in ADHD symptomatology experience the most benefit. Of note, these results contrast with those by Looby et al. (2019), who found that effects of PBS were most pronounced for women high in hyperactivity/impulsivity. However, there are important methodological and sample differences that may account for these inconsistencies, including that the prior research did not assess alcohol-related problems or differentiate by PBS domain, and only sampled students mandated to alcohol treatment.

Regarding the helpfulness of PBS for students with ADHD symptoms, there are some important clinical implications to consider. Neither ADHD symptom dimension was significantly negatively associated with any PBS domain, indicating that higher levels of inattention or hyperactivity/impulsivity do not prohibit effective PBS use in students experiencing ADHD symptoms. While ADHD symptoms may interfere with PBS use, perhaps through failure to plan or to follow through on planned strategies, students experiencing these symptoms clearly can utilize PBS, and do so effectively. Thus, promotion of PBS to all college students, including those experiencing ADHD symptoms, is likely to be beneficial. That students with higher levels of ADHD symptoms reported the most drinks and related problems with infrequent use of manner of drinking and stopping/limiting drinking PBS suggests that explicit instruction in these specific strategies may be necessary for these students, particularly male students high in inattention. Examples of how to employ and remember to utilize strategies should be offered, such as enlisting a friend to remind them of their set drink limits, or setting an alarm reminder to eat or drink water between drinks. As serious harm reduction PBS use was associated with fewer negative consequences for all students, regardless of ADHD symptoms and sex, these strategies should similarly be promoted. It is important to note that use of these strategies was positively associated with quantity of alcohol use, likely reflecting that students utilizing these strategies may be most at-risk for problems due to higher baseline drinking levels. Consequently, serious harm reduction strategies should be particularly promoted to heavy drinking students when the targeted goal is to reduce related problems.

Considering generalizability, our findings demonstrate that PBS are effective for a mostly-female and mostly-white group of undergraduates with ADHD symptoms. Given sample constraints and statistical power, we could not conduct fine-grained analyses that adequately examined the pattern of results in other subgroups (e.g., students of color, varied gender or sexual orientation status). Further, ADHD symptom dimensions were used as continuous predictors in our analytic models, rather than comparing groups based on clinically-established diagnoses. While significant effects still emerged, this may underplay the relation of the full-blown disorder to PBS and alcohol use. College students with subthreshold levels of ADHD may not experience the significant impairment seen in those with an ADHD diagnosis, necessitating more research with a clinical sample.

Next, the current results are founded on cross-sectional and self-report data. Longitudinal approaches are necessary to assess the direction and possible causality of these relationships. Further, it is understood that individuals with ADHD may have limited insight into and underreport their symptoms (Sibley et al., 2012) or otherwise be biased responders (e.g., self-handicapping; Jaconis et al., 2016). Corroboration from collateral reporters is a necessary next step in this line of research. Additionally, measurement of key variables could optimally be modified in future research. For instance, one serious alcohol-related consequence, particularly pertinent to women (Mumford, Potter, Taylor, & Stapleton, 2020), is sexual assault. This is not represented in the RAPI; consequently, the current findings may underestimate alcohol-related consequences. Future research should ensure that sexual assault is included as a negative outcome, and that both the gender-similar and -disparate alcohol-related risks are completely examined.

5. Conclusions

All types of PBS use appear to have positive benefits for undergraduates with ADHD symptoms, relating to fewer weekly drinks and negative consequences. Particularly, stopping/limiting drinking and manner of drinking strategies have incremental benefits for reducing alcohol use and related problems in college students with higher levels of inattention and/or hyperactivity/impulsivity. Furthermore, serious harm reduction strategies appear more broadly beneficial for reducing alcohol-related consequences in all students. These findings highlight the importance of including PBS in treatment programs for undergraduates with ADHD, in addition to continuing to use them in university-wide prevention programs.

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CRediT authorship contribution statement

Alison Looby: Conceptualization, Formal analysis, Writing - original draft, Visualization, Supervision. **Mark A. Prince:** Formal analysis, Writing - original draft. **John M. Vasko:** Investigation, Writing - original draft. **Lauren Zimmerman:** Investigation, Writing - original draft. **Elizabeth K. Leffer:** Writing - original draft. **Kate Flory:** Writing - original draft. **Will Canu:** Writing - original draft. **Cynthia M. Hartung:** Writing - original draft, Project administration.

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.

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