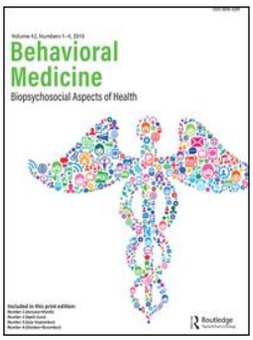

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ADHD Symptoms and Sex Moderate the Relation Between Protective Behavioral Strategies and Alcohol Use Among Treatment-Mandated College Students

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ABSTRACT

College students with attention deficit/hyperactivity disorder are likely to engage in alcohol use and experience alcohol-related problems. Use of protective behavioral strategies is related to fewer alcohol-related consequences. However, this association has not been sufficiently examined in relation to attention deficit/hyperactivity disorder symptoms, which could alter the likelihood of utilizing protective behavioral strategies. This study examined whether attention deficit/hyperactivity disorder symptoms moderate the relationship between protective behavioral strategies and alcohol use, and whether this differs by sex. Participants were 125 treatment-mandated college students (58.6% male; M_{age} = 19.50 years) who completed measures of attention deficit/hyperactivity disorder symptoms, protective behavioral strategies, and past-2-week drinking. There was a significant 3-way interaction such that drinking was highest when protective behavioral strategy use was low and hyperactivity/impulsivity symptoms were high, but only for women. There was also a significant protective behavioral strategy by inattention interaction, as students with high inattention and low protective behavioral strategy use consumed the most drinks. Interventions to enhance use of protective behavioral strategies may effectively decrease alcohol use for college students with attention deficit/hyperactivity disorder symptoms, particularly women.

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attention deficit/hyperactivity disorder symptoms; alcohol; college students; protective behavioral strategies; sex

Introduction

Diagnosis of attention deficit/hyperactivity disorder (ADHD) is associated with increased risk of alcohol use and related problems.[1,2] Given that this risk appears to be age-specific for older adolescents[3] and that college students are a particularly at-risk population for problematic alcohol use,[4] emerging adults with ADHD may be especially likely to drink heavily and experience alcohol-related problems. Indeed, several studies find that college students with ADHD exhibit higher rates of problematic alcohol use compared to those without ADHD.[5–7] Although some research finds no difference in quantity consumed between students with and without ADHD, these studies reveal that those with ADHD are still more likely to experience alcohol-related problems.[8,9] Thus, college students with ADHD may represent a uniquely vulnerable population in need of effective intervention strategies to decrease alcohol use and associated problems.

Several brief interventions demonstrate efficacy in reducing problematic alcohol use among college students in general, though little work has examined their efficacy among students with ADHD specifically. One increasingly popular approach is to enhance the utilization of protective behavioral strategies (PBS), which are active behavioral techniques employed before, during, and after alcohol consumption (eg, setting consumption limits and alternating alcoholic and nonalcoholic beverages), with the goal of reducing or eliminating use and negative alcohol-related consequences.[10] Cross-sectional research on PBS use reveals that it is negatively associated with alcohol consumption and alcohol-related consequences among college students.[11–13] Evidence that PBS use is a mechanism of change related to alcohol use comes from findings that it mediates intervention effects on drinking in several randomized controlled trials.[14–16] Thus, strong evidence exists suggesting that promoting PBS use may be a promising method of reducing

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alcohol use and associated consequences among college students.[17]

However, alcohol-related PBS use among students with ADHD has not been adequately examined. It is possible that symptoms of ADHD may limit effective utilization of PBS, and that negative associations between PBS and alcohol use may not be evident in this population. For example, ADHD-related disruptions in executive functioning, stemming from either inattention or hyperactive/impulsive symptoms, may affect the procedures necessary to conceptualize personal alcohol consumption, determine potential changes, and use self-control while consuming alcohol, including implementing any desired changes to behavioral repertoires. On the other hand, behavioral interventions (eg, cognitive-behavioral therapy) for adult ADHD are efficacious,[18–20] indicating that the use of easily employed behavioral strategies to reduce alcohol use may be particularly beneficial for college students with ADHD.

To date, only one study has examined the association between ADHD, PBS, and alcohol use, finding no differences in endorsement of PBS use between college students with and without an ADHD diagnosis, and no ADHD-related moderation of PBS on alcohol use or consequences.[21] Though not specific to ADHD, another study found that PBS use was negatively associated with alcohol use only for college students with poor self-regulation abilities.[22] Self-regulation refers to the ability to adjust behaviors and cognitions to align with goal-directed behaviors and achieve goal attainment,[23] and tends to be impaired among individuals with ADHD.[24] Thus, additional research on the use of PBS among individuals with ADHD is warranted and may be best examined through separate assessment of ADHD symptom dimensions, as students with higher levels of inattentive or hyperactive/impulsive symptoms may demonstrate differential associations between PBS and alcohol use.

Research examining whether ADHD symptom dimensions demonstrate unique associations with alcohol use is equivocal. For example, some research finds that inattention, but not hyperactivity/impulsivity, is related to alcohol-related problems,[9] yet other studies find no differences between symptomatology type and alcohol use.[25–27] Further, as symptoms of hyperactivity/impulsivity are less commonly endorsed by adults,[28] some studies have not considered these symptoms distinctly when examining relations with alcohol use.[5] For these reasons, separate examinations of relations among ADHD symptom dimensions with PBS and alcohol use are warranted.

One final potentially important variable to consider with regard to PBS use and ADHD symptoms is that of sex. Although men are more likely to be diagnosed with ADHD[29] and to engage in more frequent and larger quantities of alcohol use,[30] women are more likely to engage in PBS and to experience PBS-related reductions in alcohol use.[12] Following from studies finding that PBS may be uniquely effective for students experiencing psychological distress,[22,31–33] female college students with high levels of ADHD symptoms may experience the largest alcohol-related benefits of PBS use. Further research into the use and efficacy of PBS among college students with ADHD symptoms is needed to better understand if and how these strategies can be effectively employed in this population, and whether they may be most effective for particular types of individuals.

The aim of the present study was to examine whether the relation between PBS and alcohol use was differentially influenced by sex and ADHD symptomatology among college student drinkers who were referred to treatment. Treatment-mandated students report significantly greater amounts of alcohol use and associated problems compared to non-mandated peers, though they appear to be similarly receptive to brief interventions, including harm reduction approaches.[34] As students with ADHD are similarly likely to experience elevated rates of alcohol-related problems, yet may have difficulty engaging with and implementing harm reduction strategies due to impairments in planning and goal-setting, we examined these relations among a treatment-mandated sample to understand whether referred students with ADHD symptoms may similarly benefit from interventions commonly employed in college settings. Knowledge that treatment-referred students with ADHD symptomatology demonstrate negative associations between PBS use and alcohol use is important in understanding whether these students can similarly benefit from brief alcohol-related interventions. Further, we examined these associations separately across symptoms of inattention and hyperactivity/impulsivity. Although these symptoms are highly correlated, they are considered distinct constructs.[35,36] As ADHD is a heterogeneous disorder, examining relations between sex and PBS use across symptom dimensions would allow for a more precise understanding of underlying mechanisms that may relate to alcohol use and treatment utilization.

Table 1. Descriptive statistics and correlations between study variables.

	1	2	3	4
Full Sample				
1. Inattention	—			
2. Hyperactivity/Impulsivity	0.67*	—		
3. PBS Use	−0.10	0.02	—	
4. Alcohol Use	0.08	0.06	−0.35*	—
Mean (*SD*)	3.74 (4.06)	4.52 (4.00)	24.55 (5.90)	11.28 (10.36)
Women				
1. Inattention	—			
2. Hyperactivity/Impulsivity	0.77*	—		
3. PBS Use	−0.11	−0.03	—	
4. Alcohol Use	0.08	0.13	−0.52*	—
Mean (*SD*)	4.09 (4.98)	5.21 (4.94)	25.19 (6.54)	9.86 (11.00)
Men				
1. Inattention	—			
2. Hyperactivity/Impulsivity	0.49*	—		
3. PBS Use	−0.10	0.06	—	
4. Alcohol Use	0.11	0.00	−0.15	—
Mean (*SD*)	3.48 (3.20)	3.99 (3.02)	24.07 (5.35)	12.35 (9.78)

Note. PBS = Protective Behavioral Strategies. Alcohol Use refers to past 2-week drinks. There were no significant sex differences on any variable.
*$p < .001$.

We first hypothesized that, consistent with prior research,[12] higher PBS use would be most associated with lower alcohol use for women than for men. We were additionally interested in examining the 3-way interactions among PBS use, sex, and ADHD dimensions. Based on prior research finding PBS to be most effective for students with self-regulation difficulties,[22] and the conceptualization of ADHD as a deficit in self-regulated behavior,[37] we hypothesized that PBS use may be most associated with lower levels of drinking among women who are high in levels of either inattention or hyperactivity/impulsivity. Given inconsistencies and limitations of prior research examining relations between ADHD symptoms and alcohol use, we did not posit any a priori hypotheses regarding differential effects of hyperactivity/impulsivity versus inattention symptoms.

Method

Participants

Participants were 125 students from a Rocky Mountain West University who were referred to an Alcohol Wellness Alternatives Research and Education (AWARE) program by university offices and local court systems following a campus or community alcohol violation. The sample was comprised of 71 men (56.8%) and was predominantly White (93.6%). Average age was 19.50 years ($SD = 1.60$; range = 18–27) and participants were most likely to be freshmen (47.1%), followed by sophomores (31.1%), juniors (15.1%), seniors (4.2%), and graduate students (2.5%).

Measures

Current symptoms scale

ADHD symptoms were assessed via the Current Symptoms Scale,[38] an 18-item self-report measure of behavioral indices of inattention, hyperactivity, and impulsivity. Items are similar to the *DSM-5* criteria for ADHD[39] and measure past 6-month endorsement of symptoms on a scale ranging from 0 (never or rarely) to 3 (very often). Nine items each are summed to compute an inattention score ($\alpha = .88$) and a hyperactivity/impulsivity score ($\alpha = .83$).

Daily drinking questionnaire

Alcohol use was assessed via the Daily Drinking Questionnaire (DDQ[40]). Participants reported the number of standard drinks (specified as 12 oz beer, 5 oz wine, or 1.5 oz liquor) consumed on each day in the prior two weeks. Drinks were summed for a past-two-week drinking score.

Protective behavioral strategies

PBS use was assessed using a 9-item scale adapted from the American College Health Association-National College Health Assessment.[41] Participants were asked to indicate the frequency with which they engaged in each protective behavior (eg, keeping track of the number of drinks consumed, setting a drink limit ahead of time, eating before/while drinking) in the recent past along a 5-point scale ranging from 0 (never) to 4 (always). Scores were summed to create a total PBS score, with higher scores indicating greater PBS use ($\alpha = .84$).

Procedure

This research was approved by the University's Institutional Review Board and all participants provided written informed consent. The current study occurred within the context of a larger AWARE program evaluation study. Participants completed the Current Symptoms Scale, the DDQ, and the PBS measure at baseline, prior to beginning the AWARE program.

Data analytic plan

Data were evaluated using the PROCESS v3.0 macro for SPSS.[42] All regression models were conducted separately for symptoms of inattention and hyperactivity/impulsivity while controlling for levels of the other symptom. Predictor variables of past two-week drinks (ie, sex, inattention symptoms, hyperactivity/impulsivity symptoms, PBS) were centered for the analyses. Model 3 was specified in PROCESS to examine three-way interactions; if higher-order interaction terms were not significant, the model was re-specified without those terms and run again to simplify results. Tests of simple slopes were subsequently used to aid in the interpretation of the results, using the 16th and 84th percentiles of the distribution to denote levels at which to evaluate the moderator.[42]

Results

Means, standard deviations, and correlations are provided for all study variables in Table 1. Inattention and hyperactivity/impulsivity scores were significantly positively correlated. Average ADHD symptom scores were low among participants, though scores ranged from 0 to 22 for both symptom categories (possible range was 0 – 27). As predicted, alcohol use and PBS use were significantly negatively correlated for women, but not for men. There were no significant sex differences for any study variable.

To examine whether ADHD symptoms interacted with both PBS use and sex, two separate regressions were conducted to examine three-way interactions including either inattention or hyperactivity/impulsivity symptoms. The model regressing PBS use by inattention symptoms by sex on past two-week drinking, while controlling for hyperactivity/impulsivity symptoms, was significant ($F_{(8,116)} = 3.46$, $p = .001$). However, the three-way interaction and the sex by inattention terms were not significant, so the model was re-specified in PROCESS as Model 2 to only allow for the two-way interactions between PBS by sex and PBS by inattention. The overall model was again significant ($F_{(6,118)} = 4.67$, $p < .001$; see Table 2), as were both two-way interactions. The association between PBS use and drinking depended on level of inattentive symptoms. Specifically, at low levels of inattention, level of PBS use was not differentially associated with drinking ($t = -1.34$, $p = .182$). However, at high levels of inattention symptoms, higher levels of PBS use was significantly associated with consuming fewer drinks ($t = -4.32$, $p < .001$; see Figure 1). The association between PBS use and drinking also depended on sex, as high levels of PBS use was significantly associated with reduced drinking for women ($t = -4.26$, $p < .001$) but not for men ($t = -1.33$, $p = .186$; see Figure 1).

Table 2. Regression models of the interactions between PBS, ADHD symptoms, and sex predicting alcohol use.

					95% CI of Estimate	
Variable	β	SE	t	p	LL	UL
Inattention Model						
PBS	−0.54	0.15	−3.56	.001	−0.83	−0.24
Inattention	0.07	0.29	0.23	.817	−0.51	0.64
H/I	0.22	0.30	0.75	.456	−0.36	0.81
Sex	−2.27	1.76	−1.29	.198	−5.75	1.21
PBS × Inattention	−0.09	0.04	−2.16	.033	−0.18	−0.01
PBS × Sex	−0.59	0.29	−2.01	.046	−1.17	−0.01
Hyperactivity/Impulsivity Model						
PBS	−0.51	0.15	−3.37	.001	−0.81	−0.21
Inattention	−0.14	0.30	−0.46	.645	−0.72	0.45
H/I	0.37	0.32	1.18	.242	−0.25	1.00
Sex	−2.34	1.75	−1.33	.185	−5.81	1.13
PBS × H/I	−0.04	0.04	−0.85	.395	−0.12	−0.05
PBS × Sex	−0.47	0.30	−1.57	.118	−1.05	0.12
H/I × Sex	0.60	0.49	1.24	.217	−0.36	1.57
PBS × H/I × Sex	−0.18	0.08	−2.12	.036	−0.34	−0.01

Note. PBS = Protective Behavioral Strategies. CI = Confidence Interval. LL = Lower Limit. UL = Upper Limit. H/I = Hyperactivity/Impulsivity. Inattention Model: $F_{(6,118)} = 4.67$, $p < .001$, $R^2 = 0.19$. Hyperactivity/Impulsivity Model: $F_{(8.116)} = 3.46$, $p = .001$, $R^2 = 0.19$.

The overall model examining the effect of hyperactivity/impulsivity symptoms by PBS use by sex on past 2-week drinking, while controlling for inattentive symptoms, was significant ($F_{(8,116)} = 3.91$, $p < .001$; see Table 2), as was the three-way interaction term. The conditional effect of the PBS by hyperactivity/impulsivity interaction was significant for women ($F_{(1,116)} = 7.14$, $p = .009$) but not for men ($F_{(1,116)} = 0.37$, $p = .543$; see Figure 2). For women, when hyperactivity/impulsivity symptoms were low, drinking was relatively low, regardless of level of PBS use ($t = -1.00$, $p = .319$). However, when hyperactivity/impulsivity symptoms were high, drinking for women depended on level of PBS use ($t = -5.04$, $p < .001$), such that quantity of alcohol use was high when PBS use was low, and low when PBS use was high. For men, alcohol use did not significantly differ regardless of PBS use or hyperactivity/impulsivity symptoms.

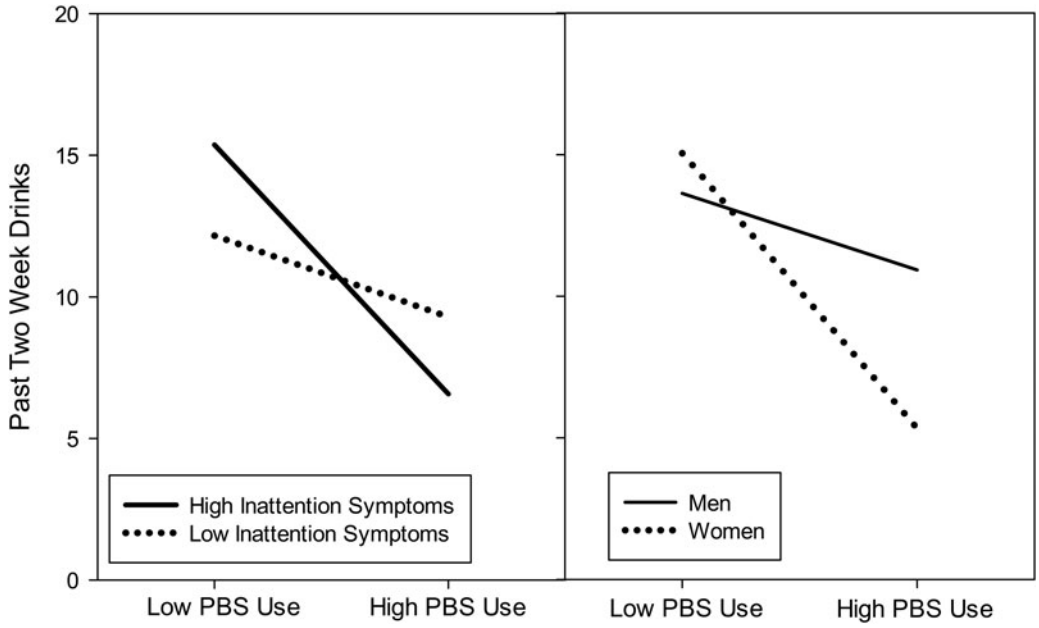

Figure 1. Two-way interactions from the inattention regression model. Conditional effect of PBS use on drinking among participants low in inattention symptoms: $t = -1.34$, $p = .182$, 95% Confidence Interval (CI) $= -0.72, 0.14$. Conditional effect of PBS use on drinking among participants high in inattention symptoms: $t = -4.32$, $p < .001$, 95% CI $= -1.30, -0.48$. Conditional effect of PBS use on drinking for men: $t = -1.33$, $p = .186$, 95% CI $= -0.71, 0.14$. Conditional effect of PBS use on drinking for women: $t = -4.26$, $p < .001$, 95% CI $= -1.26, -0.46$.

Discussion

Given the high rates of alcohol use and associated problems among college students with ADHD,[2] examination of the use of easily accessible behavioral strategies to reduce use among these students is warranted. The present study evaluated whether alcohol use among a sample of college students mandated to alcohol-related treatment was differentially associated with PBS use, ADHD symptoms, and sex. Though cross-sectional, results from the current research add to the growing body of literature suggesting that PBS use may be importantly related to lower alcohol use and associated problems for individuals experiencing psychiatric symptoms and self-regulation difficulties,[22] especially among women.[12]

Our results continued to support the growing body of evidence that PBS use is more common and effective among female college students. Importantly though, there was a significant 3-way interaction among sex, PBS use, and ADHD symptoms, such that alcohol use was only differentially associated with levels of PBS use and hyperactivity/impulsivity symptoms for women. Although men reported a moderate number of past two-week drinks regardless of ADHD symptoms or PBS use, the drinking behavior of women experiencing high levels of hyperactivity/impulsivity symptoms depended on PBS use. Women reporting high levels of hyperactivity/impulsivity and who engaged in little PBS use reported the highest number of past two-week drinks, though when high levels of symptoms were combined with more frequent PBS use, women's drinking behavior was

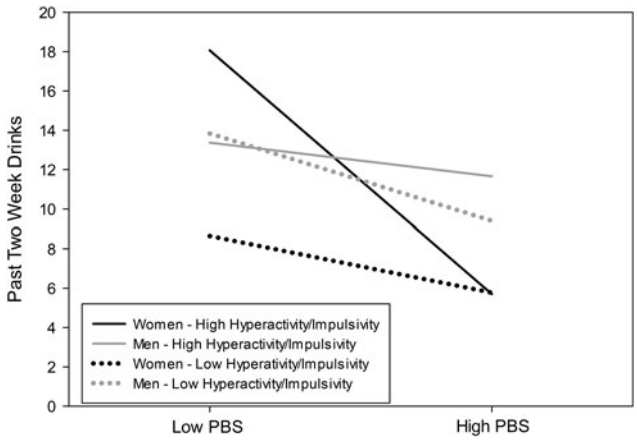

Figure 2. Three-way interaction between PBS, hyperactivity/impulsivity symptoms, and sex on alcohol use. Conditional effect of PBS use on alcohol use among men low in hyperactivity/impulsivity symptoms: $t = -1.33$, $p = .185$, 95% Confidence Interval (CI) $= -1.12, 0.22$. Conditional effect of PBS use on alcohol use among men high in hyperactivity/impulsivity symptoms: $t = -0.60$, $p = .548$, 95% CI $= -0.74, 0.40$. Conditional effect of PBS use on alcohol use among women low in hyperactivity/impulsivity symptoms: $t = -1.00$, $p = .319$, 95% CI $= -0.87, 0.29$. Conditional effect of PBS use on alcohol use among women high in hyperactivity/impulsivity symptoms: $t = -5.05$, $p < .001$, 95% CI $= -1.75, -0.76$.

substantially lower. These women, who experienced high levels of ADHD symptoms but who also employed high levels of PBS use, reported drinking behavior that was comparable to women low in hyperactivity/impulsivity, and for whom frequency of PBS use was not differentially associated with alcohol use.

For the inattention model, though there was not a significant three-way interaction, there were significant 2-way interactions. Comparable again with prior results, higher levels of PBS use was significantly associated with lower levels of alcohol use for women only. Further, inattention symptoms moderated the relation between PBS use and drinking. PBS use was not differentially related to alcohol use among students low in inattention symptoms. However, when experiencing a large number of inattention symptoms, low PBS use was related to high levels of alcohol use, while frequent PBS use was related to substantially lower amounts of alcohol.

To date, only one other study has specifically examined ADHD symptomatology in relation to PBS and alcohol use, finding disparate results from the current study in that ADHD diagnosis did not moderate the relation between PBS and alcohol use.[21] This former study utilized a small sample of students with ADHD ($n = 31$), which may have limited power to detect significant effects. In addition, the participants with ADHD may not have been a representative sample, as they tended to report less heavy drinking and fewer alcohol problems compared to non-ADHD subjects. In contrast, results from the current study examined relations among PBS, alcohol use, and ADHD at the symptom level (ie, examining this relation separately by level of inattention symptoms and level of hyperactive/impulsive symptoms) among college students mandated to treatment, indicating that they were experiencing alcohol-related problems. Consequently, PBS use may be particularly important for reducing use among students experiencing high levels of both inattention and hyperactivity/impulsivity symptoms, as well as problems associated with their alcohol use.

Moreover, this may be chiefly relevant for women experiencing ADHD symptoms, specifically those of hyperactivity/impulsivity. Howard and Pritchard[21] did not report on the sex of their participants, so it is unknown whether demographic differences between samples may have additionally contributed to discordant findings, and specifically that failure to include sex in the model may have suppressed their interactive effect. Only one study has examined the relation between PBS use and sex among individuals with psychiatric symptoms,[31] finding that PBS use appears uniquely protective for White women irrespective of levels of depression or anxiety. Although our results provide additional support for the finding that PBS use is most related to lower alcohol use for women, they also reveal that women with specific types of impairments, perhaps those related to self-regulation difficulties, may be most susceptible to heavy drinking, yet benefit most from utilizing PBS. They also highlight the necessity of attending to sex differences when examining the influence of PBS use and psychiatric symptoms on drinking.

In the present study, women who were high on hyperactivity/impulsivity reported drinking more than men who were high on the same dimension. This may be due to having a more severe externalizing predisposition.[43] This is even more significant when considering that the recommended amount of alcohol for women is lower than that for men.[44] Thus, women high on hyperactivity/impulsivity who reported approximately 20 drinks in the last two weeks are demonstrating a significantly greater health risk than men high on hyperactivity/impulsivity who reported approximately 13 drinks per week. On the other hand, women who are high on hyperactivity/impulsivity and using high levels of PBS are drinking at the same rates as women who are low on this dimension. It is also important to acknowledge that despite the lack of a significant three-way interaction in the inattention model, inattention symptoms did significantly moderate the relation between PBS and alcohol use across both sexes. Level of alcohol use was nearly 2.5 times greater among students high in inattention who engaged in low levels of PBS compared to students high in inattention who engaged in high levels of PBS. Further, students high in both inattention and PBS use reported lower levels of drinking compared to students low in inattention, regardless of their PBS use. Taken together, these results highlight the meaningful clinical impact that encouraging PBS use may have for students high in symptoms of either inattention or hyperactivity/impulsivity, particularly considering the cost- and time-efficiency of this intervention.

As hyperactivity/impulsivity in adults is manifested by symptoms including internal restlessness, making impulsive decisions, disregarding future consequences, and having difficulty deferring gratification, and inattention symptoms in adults includes difficulty remembering goals, planning, and problem solving,[45] it is clear that self-regulation is impaired among adults with ADHD symptoms. College students who have difficulty regulating their behavior, related to the experience of inattention and/or hyperactive/impulsive symptoms, may be most likely to drink heavily and

consequently experience alcohol-related problems. As PBS can be thought of as an alcohol-specific form of behavioral self-regulation,[22] their use may support and strengthen regulatory abilities that allow college students with ADHD symptoms to better control their drinking. Despite knowledge of the protective effect that PBS use appears to have for students experiencing inattention and hyperactivity/impulsivity symptoms, it is possible that these individuals are less likely to use PBS in the first place, perhaps related to failure to plan prior to using alcohol, or difficulty remembering their goals or delaying gratification while drinking. Nevertheless, when employed, they have the potential to markedly decrease alcohol use, and future research should examine how these strategies can be most effectively employed by college students with ADHD symptoms to limit alcohol-related problems.

Several limitations highlight the need for replication and further study. As noted, this research was cross-sectional in nature and we are unable to infer causal relations between PBS and alcohol use. Examining the efficacy of harm reduction interventions that instruct college students, particularly those with ADHD symptomatology, in utilization of PBS is necessary to understand whether PBS use can be effectively taught and whether it is causally associated with a decrease in alcohol use and related problems for these students. Second, the current study examined the relation between PBS and alcohol use in the context of differing levels of self-reported ADHD symptoms, rather than at the diagnostic level. Thus, although our results demonstrate that relations between PBS and alcohol use differ according to self-reported levels of inattention and hyperactivity/impulsivity symptoms, it is unclear whether this extends specifically to, or is potentially exacerbated among, college students with an ADHD diagnosis. Future research should attempt to replicate these findings in a clinically diagnosed sample, particularly as prior research found no ADHD-related moderation of PBS on alcohol-related outcomes among students recruited from a university center for students with disabilities who self-reported ADHD diagnosis.[21]

Findings from this study are also limited to a relatively small sample of demographically homogenous students from a single university who were mandated to treatment; thus, examination in a more diverse sample of students is recommended. Further, this study specifically aimed to examine relations among PBS use, ADHD symptoms, and alcohol among college students, and the findings may not generalize to emerging adults with ADHD symptoms who do not attend college, and who may experience more impairing symptoms or have fewer societal resources. Thus, future research examining whether these variables similarly relate in young adults with ADHD symptoms who do not attend college is necessary to more comprehensively understand the interactive effects of ADHD symptoms and PBS use on drinking behavior.

Additionally, this study only examined alcohol use and did not assess the relation between PBS use and alcohol-related problems (eg, fights or arguments, DUI, injury). Given that ADHD appears particularly associated with alcohol-related problems above and beyond quantity of use,[8] it will be important to understand whether PBS use similarly moderates the relation between ADHD symptoms and alcohol-related negative consequences. Finally, information on type of PBS (ie, limiting/stopping drinking, manner of drinking, serious harm reduction[46]) most associated with lower alcohol use could not be assessed via the PBS measure included in this study, though doing so may provide direction for the specific content of PBS-related interventions that are most effectively used by students with ADHD symptoms.

Conclusions

Results from this study support and extend prior research finding that college students with self-regulatory difficulties may be uniquely protected from heavy alcohol use and related problems via use of PBS, by revealing ADHD symptom-moderated relations between PBS and alcohol use. Interventions directed towards college students with ADHD symptoms that promote frequent PBS use and that instruct students in how to employ these strategies may be successful in preventing or reducing problematic alcohol use among this high-risk group. As PBS use has consistently been more frequently reported by and yields superior outcomes for women compared to men, efforts to understand the specific strategies that are most protective and readily employed by men are needed. Nevertheless, the current study provides important implications regarding the potential efficacy of cost-effective and easily implemented behavioral strategies to reduce problematic alcohol use among college students experiencing ADHD symptoms.

Conflict of interest

The authors have no conflicts of interest to disclose.

References

[1] Molina BSG, Pelham WE. Childhood predictors of adolescent substance use in a longitudinal study of

children with ADHD. *J Abnorm Psychol.* 2003; 112(3):497–507. doi:10.1037/0021-843X.112.3.497.

[2] Wilens TE, Martelon M, Joshi G. Does ADHD predict substance-use disorders? A 10-year follow-up study of young adults with ADHD. *J Am Acad Child Adolesc Psychiatry.* 2011;50(6):543–553. doi:10.1016/j.jaac.2011.01.021.

[3] Molina BSG, Pelham WE, Gnagy EM, Thompson AL, Marshal MP. Attention-deficit/hyperactivity disorder risk for heavy drinking and alcohol use disorder is age specific. *Alcohol Clin Exp Res.* 2007; 31(4):643–654. doi:10.1111/j.1530-277.2007.00349.x.

[4] Knight JR, Wechsler H, Kuo M, Seibring M, Weitzman ER, Schuckit MA. Alcohol abuse and dependence among U.S. college students. *J Stud Alcohol.* 2002;63(3):263–270. doi:10.15288/jsa.2002.63.263.

[5] Baker L, Prevatt F, Proctor B. Drug and alcohol use in college students with and without ADHD. *J Atten Disord.* 2012;16(3):255–263. doi:10.1177/1087054711416314.

[6] Blase SL, Gilbert AN, Anastopoulos AD, et al. Self-reported ADHD and adjustment in college: cross-sectional and longitudinal findings. *J Atten Disord.* 2009;13(3):97–309. doi:10.1177/1087054709334446.

[7] Rooney M, Chronis-Tuscano A, Yoon Y. Substance use in college students with ADHD. *J Atten Disord.* 2012;16(3):221–234. doi:10.1177/1087054710392536.

[8] Glass K, Flory K. Are symptoms of ADHD related to substance use among college students? *Psychol Addict Behav.* 2012;26(1):124–132. doi:10.1037/a0024215.

[9] Mesman GR. The relation between ADHD symptoms and alcohol use in college students. *J Atten Disord.* 2015;19(8):694–702. doi:10.1177/1087054713498931.

[10] Prince MA, Carey KB, Maisto SA. Protective behavioral strategies for reducing alcohol involvement: a review of the methodological issues. *Addict Behav.* 2013;38(7):2343–2351. doi:10.1016/j.addbeh.2013. 03.010.

[11] LaBrie JW, Kenney SR, Lac A. The use of protective behavioral strategies is related to reduced risk in heavy drinking college students with poorer mental and physical health. *J Drug Educ.* 2010;40(4): 361–378. doi:10.2190/DE.40.4.c.

[12] LaBrie JW, Lac A, Kenney SR, Mirza T. Protective behavioral strategies mediate the effect of drinking motives on alcohol use among heavy drinking college students: gender and race differences. *Addict Behav.* 2011;36(4):354–361. doi:10.1016/j.addbeh.2010.12.013.

[13] Martens MP, Taylor KK, Damann KM, Page JC, Mowry ES, Cimini D. Protective behavioral strategies when drinking alcohol and their relationship to alcohol-related consequences in college students. *Psychol Addict Behav.* 2004;18(4):390–393. doi:10.1037/0893-164X.18.4.390.

[14] Barnett NP, Murphy JG, Colby SM, Monti PM. Efficacy of counselor vs. computer-delivered intervention with mandated college students. *Addict Behav.* 2007;32(11):2529–2548. doi:10.1016/j.addbeh.2007.06.017.

[15] Larimer ME, Lee CM, Kilmer JR, et al. Personalized mailed feedback for college drinking prevention: a randomized clinical trial. *J Consult Clin Psychol.* 2007;75(2):285–293. doi:10.1037/0022-006X.75.2.285.

[16] Murphy JG, Dennhardt AA, Skidmore JR, et al. A randomized controlled trial of a behavioral economic supplement to brief motivational interventions for college drinking. *J Consult Clin Psychol.* 2012;80(5): 876–886. doi:10.1037/a0028763.

[17] Pearson MR. Use of alcohol protective behavioral strategies among college students: a critical review. *Clin Psychol Rev.* 2013;33(8):1025–1040. doi:10.1016/j.cpr.2013.08.006.

[18] Safren SA. Cognitive-behavioral approaches to ADHD treatment in adulthood. *J Clin Psychiatry.* 2006;67(suppl 8):46–50.

[19] Safren SA, Sprich S, Mimiaga MJ, et al. Cognitive behavioral therapy vs relaxation with educational support for medication-treated adults with ADHD and persistent symptoms. *JAMA.* 2010;304(8): 875–880. doi:10.1001/jama.2010.1192.

[20] Solanto MV. *Cognitive-Behavioral Therapy for Adult ADHD: Targeting Executive Dysfunction.* New York, NY: The Guilford Press; 2011.

[21] Howard AL, Pritchard TR. Heavy drinking in university students with and without attention-deficit/hyperactivity disorder: contributions of drinking motives and protective behavioral strategies. *Subst Abuse.* 2017;11:1–10. doi:10.1177/1178221817723318.

[22] D'Lima GM, Pearson MR, Kelley ML. Protective behavioral strategies as a mediator and moderator of the relationship between self-regulation and alcohol-related consequences in first-year college students. *Psychol Addict Behav.* 2012;26(2):330–337. doi:10.1037/a0026942.

[23] Tangney JP, Baumeister RF, Boone AL. High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *J Personality.* 2004;72(2):271–324. doi:10.1111/j.0022-3506.2004.00263.x.

[24] Shiels K, Hawk LW. Self-regulation in ADHD: the role of error processing. *Clin Psychol Rev.* 2010; 30(8):951–961. doi:10.1016/j.cpr.2010.06.010.

[25] Clure C, Brady KT, Saladin ME, et al. Attention-deficit/hyperactivity disorder and substance use: symptom pattern and drug choice. *Am J Drug Alcohol Abuse.* 1999;25(3):441–448. doi:10.1081/ADA-100101871.

[26] Roberts W, Peters JR, Adams ZW, et al. Identifying the facets of impulsivity that explain the relation between ADHD symptoms and substance use in a nonclinical sample. *Addict Behav.* 2014;39(8): 1272–1277. doi:10.1016/j.addbeh.2014.04.005.

[27] Sihvola E, Rose RJ, Dick DM, et al. Prospective relationships of ADHD symptoms with developing substance use in a population-derived sample. *Psychol Med.* 2011;41(12):2615–2623. doi:10.1017/S0033291711000791.

[28] Wilens TE, Biederman J, Faraone SV, et al. Presenting ADHD symptoms, subtypes, and comorbid disorders in clinically referred adults with ADHD. *J Clin Psychiatry.* 2009;70(11):1557–1562. doi:10.4088/JCP.08m04785pur.

[29] Ramtekkar UP, Reiersen AM, Todorov AA, Todd RD. Sex and age differences in Attention-Deficit/Hyperactivity Disorder symptoms and diagnoses: implications for DSM-V and ICD-11. *J Am Acad Child Adolesc Psychiatry*. 2010;49(3):217–228. doi: 10.1016/j.jaac.2009.11.011.

[30] Wilsnack RW, Vogeltanz ND, Wilsnack SC, Harris TR. Gender differences in alcohol consumption and adverse drinking consequences: cross-cultural patterns. *Addiction*. 2000;95(2):251–265. doi:10.1046/j.1360-0443.2000.95225112.x.

[31] Kenney SR, LaBrie W. Use of protective behavioral strategies and reduced alcohol risk: examining the moderating effects of mental health, gender and race. *Psychol Addict Behav*. 2013;27(4):997–1009. doi: 0.1037/a0033262. doi:10.1037/a0033262.

[32] LaBrie JW, Kenney SR, Lac A, Garcia JA, Ferraiolo P. Mental and social health impacts the use of protective behavioral strategies in reducing risky drinking and alcohol consequences. *J Coll Stud Dev*. 2009;50(1):35–49. doi:10.1353/csd.0.0050.

[33] Litt DM, Lewis MA, Blayney JA, Kaysen DL. Protective behavioral strategies as a mediator of the generalized anxiety and alcohol use relationship among lesbian and bisexual women. *J Stud Alcohol Drugs*. 2013;74(1):168–174. doi:10.15288/jsad.2013.74.168.

[34] Barnett NP, Tevyaw TO, Fromme K, et al. Brief alcohol interventions with mandated or adjudicated college students. *Alcohol Clin Exp Res*. 2004;28(6):966–975. doi:10.1097/01.ALC.0000128231.97817.C7.

[35] DuPaul GJ, Schaughency EA, Weyandt LL, et al. Self-report of ADHD symptoms in university students: cross-gender and cross-national prevalence. *J Learn Disabil*. 2001;34(4):370–379. doi:10.1177/002221940103400412.

[36] Willcutt EG, Nigg JT, Pennington BF, et al. Validity of DSM-IV attention-deficit/hyperactivity disorder symptom dimensions and subtypes. *J Abnorm Psychol*. 2012;121(4):991–1010. doi:10.1037/a0027347.

[37] Barkley RA. *Attention-Deficit Hyperactivity Disorder: A Handbook for Diagnosis and Treatment* (4th ed.). New York, NY: Guilford Press; 2015.

[38] Barkley RA, Murphy KR. *Attention-Deficit Hyperactivity Disorder: A Clinical Workbook* (3rd ed.). New York, NY: Guilford Press; 2006.

[39] American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing; 2013.

[40] Collins RL, Parks GA, Marlatt GA. Social determinants of alcohol consumption: the effects of social interaction and model status on the self-administration of alcohol. *J Consult Clin Psychol*. 1985;53(2):189–200. doi:10.1037//0022-006X.53.2.189.

[41] American College Health Association. *American College Health Association – National College Health Assessment: Reference Group Data Report Fall 2004*. Baltimore, MD: American College Health Association; 2005. http://www.acha-ncha.org/docs/ACHA-NCHA_Reference_Group_Report_Fall2004.pdf.

[42] Hayes AF. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach* (2nd ed.). New York, NY: The Guilford Press; 2018.

[43] Beauchaine TP, McNulty T. Comorbidities and continuities as ontogenic processes: Toward a developmental spectrum model of externalizing psychopathology. *Dev Psychopathol*. 2013;25(4pt2):1505–1528. doi:10.1017/S0954579413000746.

[44] U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015-2020 Dietary Guidelines for Americans (8th ed.). http://health.gov/dietaryguidelines/2015/guidelines. Published December, 2015. Accessed July 10, 2018.

[45] Barkley RA. Differential diagnosis of adults with ADHD. *J Clin Psychiatry*. 2010;71(:7):e17. doi: 10.4088/JCP.9066tx1c.

[46] Martens MP, Ferrier AG, Sheehy MJ, Corbett K, Anderson DA, Simmons A. Development of the protective behavioral strategies survey. *J Stud Alcohol*. 2005;66(5):698–705. doi:10.15288/jsa.2005.66.698.