

**Protective Behavioral Strategies and Alcohol Problems in Heavy Drinking College
Students: The Role of ADHD Symptoms and Sex Differences**

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PSYC 499H: Honors Thesis Research

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Author Note

This research was funded by a grant awarded to Lauren Oddo, M.S. (NIAAA F31 AA027937)

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Abstract

College students with attention-deficit/hyperactivity disorder (ADHD) are at risk for alcohol-related negative consequences, but key correlates of risks for this population are unknown. Use of protective behavioral strategies (PBS) are designed to mitigate the negative consequences of drinking, but people with ADHD may be at-risk for underutilizing PBS. This study evaluated group differences in PBS use and alcohol variables by ADHD status and biological sex. Participants were full-time undergraduate students (49% female; ages 18-22) with ($n=42$) and without ($n=37$) ADHD. Students were screened for high-risk alcohol use and completed measures of alcohol use, alcohol-related negative consequences and PBS. Despite no significant differences among drinking variables, students with ADHD reported more alcohol-related negative consequences compared to their similarly-drinking peers. Males reported more drinks per week, but had comparable binge drinking and intoxication episodes to females, where surprisingly, females reported significantly more alcohol-related negative consequences than males. As predicted, students with ADHD and males reported using fewer total PBS than non-ADHD peers and females. Contrary to expectations, moderation analyses showed no significant moderation for ADHD status on sex differences and PBS use, nor did ADHD status significantly moderate the effect of PBS use in reducing alcohol-related negative consequences. Future research should examine possible mechanisms underlying the association between ADHD and PBS utilization (i.e., emotion dysregulation, impulsivity).

Protective Behavioral Strategies and Alcohol Problems in College Students: The Role of ADHD Symptoms and Sex Differences

College is a high-risk developmental period for the initiation and escalation of harmful alcohol use (Merrill & Carey, 2016). Prevention and early intervention efforts are critical for heavy drinking college students, as this population is at elevated risk of alcohol-related negative consequences compared to same-age peers not enrolled at a 4-year college (Patrick et al., 2020). Additionally, hazardous alcohol and drug use in college can lead to adverse outcomes on learning and brain development, negatively impacting career development, educational achievement, and the risk of substance use problems later in life (see Murphy & Dennhardt, 2016 for review).

College students with attention-deficit/hyperactivity disorder (ADHD) are especially vulnerable to alcohol-related negative consequences (Rooney et al., 2012). For example, student drinkers with ADHD experience higher rates of alcohol use disorder (AUD), are more likely to get hurt or injured as a result of drinking, and report more difficulties stopping a drinking episode (Rooney et al., 2012). Yet, key correlates of risk are largely unknown.

Protective Behavioral Strategies and Alcohol Outcomes

Students who fail to deploy protective behavioral strategies (PBS) before, during, and immediately after drinking are at risk for alcohol-related negative consequences (Pearson, D'Lima, et al., 2013). PBS are considered an array of cognitive and behavioral harm reduction strategies that are designed to mitigate the negative consequences of drinking (e.g., drinking slowly, eating before or during drinking; H. Treloar et al., 2015). Failure to use PBS correlates with alcohol problems; thus, PBS are often taught in alcohol interventions to equip students with tools to reduce negative consequences from their alcohol use (Looby et al., 2019; Patrick et al.,

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2011; Schwebel et al., 2020). Specific subscales of PBS include the Manner of Drinking (MOD), such as avoiding mixing different types of alcohol, or Stopping/Limiting Drinking (SLD), which includes alternating alcoholic drinks with water, or Serious Harm Reduction (SHR) such as appointing a designated driver (H. Treloar et al., 2015).

PBS use is associated with different aspects of drinking behaviors and outcomes. That is, some research shows that an increase in PBS use predicts fewer drinks consumed (Looby et al., 2019). However, findings are mixed, with others showing that people engaging in heavier drinking use more PBS compared to low-moderate drinkers (Blanchard et al., 2018; Braitman et al., 2015; Elkins et al., 2018; Mesman, 2015). This may be because heavier drinkers are more likely to experience alcohol-related harms, and therefore may be more motivated to deploy PBS compared to lighter drinkers. Another alcohol outcome pertinent to PBS research is alcohol-related negative consequences, such as experiencing hangovers or problems with school/work or relationships due to drinking (Kahler et al., 2005). Increased PBS use is generally shown to predict fewer alcohol-related negative consequences (Montes et al., 2019; Patrick et al., 2011; Schwebel et al., 2020). Additionally, not all PBS subscales are equally effective at targeting drinking outcomes or mitigating risk. For example, one study found that the utilization of MOD PBS predicted lower odds of experiencing alcohol problems and engaging in heavy drinking compared to SLD PBS, which showed no independent relationship between PBS use and drinking variables (Howard & Pritchard, 2017). Indeed, a nuanced understanding of PBS use and the students at-risk for underutilizing these important strategies justifies that PBS subscales are explored in addition to total PBS use.

Protective Behavioral Strategies and ADHD

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Students with ADHD may be at risk for underutilizing PBS, perhaps due to characteristic deficits in self-regulation and executive function (EF; Shiels & Hawk, 2010; Wilson & Levin, 2001). Self-regulation and EF are responsible for thoughtful decision-making and organized efforts in service of delayed outcomes. In fact, people who report high self-control tend to use more PBS than do those with lower levels of self-control (D’Lima et al., 2012; Pearson, Kite, et al., 2013). To date, however, only a few studies have examined the association between ADHD symptomatology and PBS. In their cross-sectional study of students recruited through academic support services, Howard and Pritchard (2017) found that students with ADHD showed no significant differences to non-ADHD counterparts in their total PBS use. Although this study is among the first to examine PBS use in ADHD, findings are limited by an imbalanced sample (i.e., $n=43$ ADHD, $n=165$ non-ADHD), failure to account for biological sex, and reliance on a broad screener of alcohol problems. Therefore, the results of this study are muddled by a lack of information on drinking habits, alcohol-related negative consequences, and any interactive effects of sex.

Expanding on these findings in an alcohol treatment-mandated sample, Looby and colleagues (2019) evaluated the effects of ADHD symptoms on PBS use and explored differences in use between males and females in a community sample of college students unselected for ADHD. Looby et al. (2019) found that female college students with high levels of hyperactive/impulsive symptoms and low levels of PBS reported the highest number of drinks relative to any other group. However, women with high levels of hyperactive/impulsive symptoms and high levels of PBS use reported similar alcohol use trends to women who reported low levels of hyperactive/impulsive symptoms. Similarly, at low levels of inattention, PBS use was not differentially associated with drinking, whereas at high levels of inattention and high

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PBS use, students reported consuming fewer drinks. Additional research is needed to evaluate other drinking outcomes (i.e., alcohol-related negative consequences) in non-mandated samples to further refine our understanding of PBS use among student drinkers with and without ADHD, and whether students with ADHD are differentially impacted by PBS use.

These findings support the novel idea that PBS “protects the impaired” (D’Lima et al., 2012). In a recent meta-analysis, Schwebel and colleagues (2020) found that across all risk factors (i.e., depression, anxiety, sensation-seeking traits), PBS use was a robust buffer between risk factors and alcohol-related negative consequences. Specifically, people with the greatest risk for alcohol problems who deployed PBS were less likely to experience alcohol problems than their lower-risk counterparts (Schwebel et al., 2020). This study aimed to assess interaction effects of PBS use on alcohol outcomes in at-risk populations, suggesting there is a general, but nonspecific trend that PBS reduce the influence of risk factors on alcohol-related negative consequences. Although Schwebel and colleagues (2020) failed to assess people with ADHD in their sample, it is likely that drinkers with ADHD who are at risk for alcohol problems may be more protected against alcohol problems when they use PBS, compared to their non-ADHD peers.

Protective Behavioral Strategies and Sex Differences

In addition to examining the effects of ADHD on PBS and drinking outcomes, it is also important to evaluate sex differences in PBS use. Female college students are more likely to deploy more PBS than are male students (Haines et al., 2006; Palmer et al., 2010). Specifically, Treloar and colleagues (2014) found that women are more likely to “sometimes, usually or always” use PBS compared to men, who are more likely to “never, rarely or occasionally” use PBS (H. R. Treloar et al., 2014). Multiple studies find that women report using specific PBS

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items more than men, such as “go[ing] home with a friend” or “know[ing] where your drink is at all times” (Delva et al., 2004; Kenney & LaBrie, 2013; H. R. Treloar et al., 2014). Looby and colleagues (2019) found that alcohol use and PBS use were significantly negatively correlated for women, but not for men. Some have speculated that women may utilize more PBS compared to men in order to manage or avoid a high-risk sexual experience whereas men may be encouraged to be competitive with their drinking (Palmer et al., 2010). To that end, men tend to report fewer PBS items such as “avoid trying to keep up or out-drink others” or “avoid drinking games” compared to women (Delva et al., 2004; Kenney & LaBrie, 2013; H. R. Treloar et al., 2014). Investigating the differences in how men and women use PBS (including PBS subscales) provides valuable insight into who is vulnerable to underutilizing PBS.

An important consideration in research on PBS use and sex differences is statistically controlling for the number of drinks, given that men tend to consume more alcoholic beverages on average than women (Erol & Karpyak, 2015; Wechsler et al., 1995). When the number of drinks is not accounted for in models of risk, increased use of PBS may be associated with more alcohol use and alcohol-related negative consequences. For example, Miller and colleagues (2019) found that in male college students, increased use of MOD predicts more negative consequences from drinking. It may be that students who engage in heavier drinking have more opportunities to deploy PBS (e.g., avoid drinking games). Therefore, it is important to include drinking quantity in statistical models identifying any differences in PBS use among men and women to ensure an accurate and complete understanding of sex differences in PBS use.

The Current Study

College students with ADHD reported more alcohol-related negative consequences than those without ADHD (Rooney et al., 2012). Considering that PBS are intended as a tool to limit

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negative consequences of alcohol use, but require self-regulated decision-making to execute, it is important to understand if students with ADHD deploy fewer PBS compared to non-ADHD peers. It is also important to assess if PBS are equally effective in reducing alcohol-related negative consequences of drinking for college students diagnosed with ADHD relative to students without ADHD (i.e., the “PBS protect the impaired” hypothesis; Schwebel et al., 2020). Additionally, males and students with ADHD may be less likely to use these strategies compared to females and students without ADHD (Looby et al., 2019). Therefore, exploring differences in PBS use and alcohol outcomes among males and females further contributes to a more complete understanding of risk and protective factors. The current study addresses these questions in the following aims:

Aim 1. To examine group differences in PBS use (i.e., total use and subscales) by ADHD status and sex differences (i.e., male/female).

Hypothesis 1a. Relative to students without ADHD, students with ADHD will report using fewer PBS.

Hypothesis 1b. Females will be more likely to utilize PBS than males.

Aim 2. To examine group differences in drinking variables (i.e., frequency of binge drinking episodes, defined as 4+/5+ drinks over 2 hours for females/males, respectively, and more alcohol-related negative consequences) by ADHD status and sex differences (i.e., male/female).

Hypothesis 2a. Relative to students without ADHD, students with ADHD will report heavier alcohol use, more binge drinking episodes, and more alcohol-related negative consequences.

Hypothesis 2b. Males will report heavier alcohol use, more binge drinking episodes, and more alcohol-related negative consequences, relative to females.

Aim 3. To explore the interactive effects of ADHD status and sex on PBS use.

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Hypothesis 3. The association between sex and PBS use will be moderated by ADHD status, such that males with ADHD will be less likely to use PBS than females with and without ADHD and males without ADHD.

Aim 4. To explore the interactive effects of ADHD status and PBS use on alcohol-related negative consequences.

Hypothesis 4. ADHD status will buffer (i.e., moderate) the effects of PBS use on alcohol-related negative consequences, such that the effect of PBS use on reducing alcohol-related negative consequences will be stronger for students with ADHD, compared to students without ADHD.

Methods

Participants

Participants (49% female; ages 18-22) were full-time undergraduate students enrolled at the University of Maryland, College Park (UMD) with ($n=42$) and without ($n=37$) ADHD. Eligibility criteria for students with and without ADHD included: (1) engaging in at least 3 drinking episodes a week in the past month with no indication of the trend changing, (2) reporting at least one binge drinking episode in the past two weeks, (3) showing elevated levels of problem drinking as detected by the Alcohol Use Disorder Identification Test (AUDIT; Saunders et al., 1993) with a score of 7 or greater for males, and 5 or greater for females (DeMartini & Carey, 2012), and (4) being a full-time student at UMD. Participants in the ADHD group were required to meet full DSM-5 ADHD diagnostic criteria on clinician-administered diagnostic interviews¹ (American Psychiatric Association, 2013). Students in the non-ADHD group were eligible for the study if they had (1) 3 or fewer current DSM-5 symptoms of ADHD,

¹ For students who reported current ADHD symptoms but were unable to provide childhood symptom ratings due to poor recall, or for students who had subclinical (i.e., 4) ADHD symptoms, we used parent reported ADHD symptoms in order to determine group assignment ($n=3$).

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(2) reported no history of ADHD during childhood, and (3) have never been prescribed medication for ADHD. Students with or without ADHD were ineligible for the study if they met the following exclusion criteria: (1) bipolar disorder or current psychosis, or (2) evidence of concrete suicide ideation that would require immediate/intensive treatment and monitoring beyond the capacity of the study team.

Procedures

All study protocol were approved by the University of Maryland Institutional Review Board (IRB). All recruitment and study procedures occurred during fall and spring semesters, at all other times, the study remained postponed.² Students were recruited through campus listservs, flyers posted at University Counseling, the undergraduate research participation system, Accessibility and Disability support services, and word of mouth around campus. To determine study eligibility, students completed a two-step screening process. Students first completed an online screener assessing alcohol use frequency, number of binge drinking episodes, and ADHD symptoms. If initial eligibility criteria were met (i.e., (1) drinking 3 or more times in a given week, (2) reporting at least 1 binge episode in the past two weeks), students were scheduled for a phone screen with study personnel. During the phone screen, study personnel provided information about the study purposes and procedures as well as answered any questions of the students. If the student consented to the phone screen, personnel administered a brief screen to confirm whether the student met study inclusion criteria based on current drinking behaviors, prior diagnoses, medication status, and student status.

Eligible students on the phone screen were invited for an in-person or secure online zoom baseline assessment.³ During the baseline assessment, participants were asked to sign a consent

² The study was initially paused at the start of COVID-19, and then was soon continued in an online fashion.

³ Following COVID-19, baseline assessments were conducted over Zoom.

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form after all study procedures and possible risks and benefits associated with study participation were explained by a trained graduate student (“assessor”). Participants’ questions or concerns were addressed. Participants completed a semi-structured clinical interview of ADHD in addition to self-report questionnaires on alcohol use, alcohol-related negative consequences and PBS via the online survey platform, Qualtrics. Participants were compensated \$25 for their time and effort.

Measures

Phone Screen Measure

Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993). The AUDIT is a brief screener used to assess risky drinking and related impairments in the past year (Bohn et al., 1995). For the phone screen, participants were assessed for risk status based on college drinking cut-offs and were eligible for the study with a score of at least 7 for males and 5 for females. A higher score on the AUDIT indicates more risk (DeMartini & Carey, 2012). The AUDIT is found to be a valid instrument for assessing alcohol in college student populations (DeMartini & Carey, 2012; Kokotailo et al., 2004).

Baseline Measures

Adult ADHD Clinical Diagnostic Scale (ACDS; Kessler et al., 2010). The ACDS is a clinician-administered semi-structured diagnostic interview of ADHD symptoms and impairment. The ACDS includes two modules: childhood and past year. In the current study, ADHD diagnosis was based on meeting full DSM-5 diagnostic criteria (American Psychiatric Association, 2013). Participants meeting diagnostic criteria for ADHD were considered in the ADHD group (coded as 1) and those who did not evidence ADHD were considered in the control

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group (coded as 0). Master and doctoral level assessors of the ACDS all underwent extensive training where they met reliability criteria ($k > 0.80$).

Daily Drinking Questionnaire (DDQ; Collins et al., 1985). The DDQ measures the quantity and frequency of recent alcohol use. Students are asked to estimate, in a typical week in the past month, the number of drinks they consumed each day (i.e., Sunday-Saturday) and over how many hours. Students also indicate the number of binge drinking episodes in the past month (i.e., drinking 4+ drinks for women, 5+ drinks for men in a 2-hour period). Additionally, students report how often they were intoxicated in the past month. The DDQ is established as a valid and reliable measure for drinking quantity and frequency as well as perceived quantity and frequency norms among college students (Neighbors et al., 2006).

Protective Behavioral Strategies Scale 20 (PBSS-20; H. Treloar et al., 2015). The PBSS-20 is a 20-item list of PBS, including three subscales: Stopping/Limiting Drinking (SLD), Manner of Drinking (MOD), and Serious Harm Reduction (SHR). Students are asked to indicate how frequently they utilized each strategy on a 6-point Likert scale ranging from Never to Always. PBS use is captured via a total score as well as a total score on each of the three subscales, with higher scores indicating more frequent protective behavioral strategies use. The PBSS-20 is a revised version of the PBSS (Martens et al., 2005), to improve the content validity of the SHR subscale. The PBSS is psychometrically sound and shown to have excellent validity and reliability in measuring PBS use among college students (Prince et al., 2013).

Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ-30; Kahler et al., 2005). The B-YAACQ is a 24-item questionnaire where participants rate dichotomously (i.e., yes/no) whether they have experienced each negative consequence within the past 30 days. The items are scored with no=0 and yes=1 and summed to create a total score (0-14). Higher scores

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indicate more alcohol-related negative consequences. The B-YAACQ has shown internal consistency and expressed validity in assessing alcohol consequences among college students (Kahler et al., 2008).

Data Analytic Plan

Given that no known research has examined an array of alcohol use patterns among drinkers with and without ADHD and sex differences, we first sought to characterize the sample using descriptive statistics on key study variables: typical drinks per week, frequency of intoxication in the past month, and number of binge drinking episodes in the past month. To explore group differences (i.e., ADHD vs. control; male vs. female) in drinks per week, frequency of intoxication, and number of binge drinking episodes, we conducted independent samples t-tests. To examine associations between ADHD, sex, and alcohol-related negative consequences controlling for average drinks per week, we also conducted a series of multiple linear regressions.

Next, to evaluate the effect of ADHD and sex (i.e., male/female) on PBS use while controlling for drinks per week, we conducted a series of multiple linear regressions. In follow-up exploratory sensitivity analyses to evaluate each subscale of PBS, we also conducted separate linear multiple regressions with ADHD, total drinks per week, and sex regressed on each subscale of PBS (i.e., SLD, MOD, and SHR).

Following the series of multiple linear regression analyses to evaluate the independent effects of risk factors on PBS use, we explored hypothesized interactive effects. First, to examine whether the association between sex and PBS use differed for students with vs. without ADHD, we examined the interactive effect of ADHD and sex on PBS use. Second, to test the “PBS protects the impaired” hypothesis, we examined the interactive effects (i.e., moderation) of

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ADHD and PBS use on alcohol-related negative consequences, controlling for drinks per week and sex. Consistent with our goal to explore subscales of PBS, we also conducted follow-up moderation analyses with each subscale of PBS (i.e., SLD, MOD, and SHR) for both sets of moderation analyses.

Results

ADHD and Sex Differences in Alcohol Use

See Table 1 for descriptive statistics and bivariate correlations among key study variables. Students reported consuming an average of 19.39 drinks per week. Results from independent samples t-tests showed that males consumed more on average than females $t(78) = -4.03, p < 0.001$ (females: $M = 14.43, SD = 6.10$; males: $M = 23.83, SD = 13.07$), but no significant differences were observed among students with vs. without ADHD $t(78) = -.70, p = 0.49$ (ADHD: $M = 20.21, SD = 11.81$; no ADHD: $M = 18.43, SD = 10.81$). Students self-reported an average of 5.23 ($SD = 3.65$) binge drinking episodes in the past month and approximately 8.73 ($SD = 9.46$) times per month being intoxicated. Results from independent samples t-tests comparing the average frequency of bingeing episodes and number of times intoxicated revealed no statistically significant differences between males and females in bingeing $t(79) = -1.15, p = 0.25$ (females: $M = 4.74, SD = 3.14$; males: $M = 5.68, SD = 4.05$) or intoxication $t(79) = -1.35, p = 0.18$ (females: $M = 7.96, SD = 4.78$; males: $M = 9.44, SD = 5.08$). Similarly, there were no statistically significant differences between students with vs. without ADHD in bingeing $t(79) = 0.57, p = 0.57$ (ADHD: $M = 5.01, SD = 3.56$; no ADHD: $M = 5.47, SD = 3.79$) or intoxication $t(79) = -0.61, p = 0.54$ (ADHD: $M = 9.05, SD = 5.43$; no ADHD: $M = 8.37, SD = 4.42$).

ADHD and Sex Differences in Alcohol-Related Negative Consequences

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Results from the linear multiple regression analyses showed that students with ADHD reported significantly more alcohol-related negative consequences in the past month relative to their non-ADHD counterparts ($b = 2.54, B = 0.27, SE = 0.86, p < 0.01$), above and beyond weekly drinks and sex. Similarly, females were more likely to report alcohol-related negative consequences than were males ($b = -2.44, B = -0.26, SE = 0.98, p = 0.02$), controlling for weekly drinks; this effect remained even when ADHD was also included in the regression model ($b = -2.56, B = -0.27, SE = 0.94, p = 0.01$).

PBS Use

Results from a linear multiple regression evaluating the effects of ADHD and sex (controlling for total drinks per week) on total PBS use showed that ADHD ($b = -6.12, B = -0.22, SE = 2.61, p = 0.02$), sex ($b = -10.38, B = -0.37, SE = 2.86, p < 0.01$), and total drinks per week ($b = -0.37, B = -0.27, SE = 0.13, p = 0.01$) were significantly associated with total PBS use in the hypothesized directions ($F(3, 76) = 14.03, p < 0.001$). Students with ADHD and males were less likely to use PBS than students without ADHD and females; students who consumed more weekly drinks were less likely to employ PBS than were students who consumed fewer weekly drinks. Exploratory analyses with the effects of ADHD and sex (controlling for total drinks per week) regressed on each subscale of PBS showed that ADHD ($b = -1.80, B = -0.23, SE = 0.73, p = 0.02$), sex ($b = -2.54, B = -0.33, SE = 0.80, p < 0.01$), and total drinks per week ($b = -0.09, B = -0.25, SE = 0.04, p = 0.02$) were significantly associated with MOD subscale in the hypothesized directions ($F(3, 76) = 11.65, p < 0.001$). Students with ADHD and males were less likely to employ MOD than students without ADHD and females; students who consumed more weekly drinks were less likely to use MOD than students who consumed fewer weekly drinks. Only sex ($b = -3.25, B = -0.24, SE = 1.51, p = 0.04$) and total drinks per week ($b = -0.17, B = -0.29, SE =$

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0.07, $p = 0.01$) were significantly associated with SLD subscale in the hypothesized directions ($F(3, 76) = 7.30, p < 0.001$), but not ADHD ($b = -1.79, B = -0.13, SE = 1.38, p = 0.20$). Only sex ($b = -4.59, B = -0.36, SE = 1.41, p < 0.01$) was significantly associated with SHR subscale in the hypothesized directions ($F(3, 76) = 8.10, p < 0.001$), but not total drinks per week ($b = -0.08, B = -0.14, SE = 0.06, p = 0.21$), though ADHD was trending in the hypothesized direction ($b = -2.53, B = -0.20, SE = 1.29, p = 0.053$). In effect, the only consistent predictor of PBS utilization across total and subscale scores was being female.

Interactive Effects: Sex, ADHD, PBS Use and Alcohol-Related Negative Consequences

See Table 2 for results from moderation analyses examining the interactive effects of ADHD and sex on total PBS use (controlling for total weekly drinks). Findings failed to support significant differences in the association between sex and total PBS use between students with vs. without ADHD ($b = 3.30, SE = 5.24, 95\% \text{ CI } [-7.14, 13.75], p = 0.53$), such that males are less likely to use PBS regardless of ADHD status. These findings were consistent with each PBS subscale, such that no significant interaction effect of ADHD x sex was observed: MOD ($b = 1.33, SE = 1.47, 95\% \text{ CI } [-1.59, 4.26], p = 0.37$), SLD ($b = 3.74, SE = 2.74, 95\% \text{ CI } [-1.73, 9.20], p = 0.18$), and SHR ($b = -1.77, SE = 2.58, 95\% \text{ CI } [-6.91, 3.38], p = 0.50$).

See Table 3 for results from moderation analyses examining the interactive effects of PBS on the association between ADHD and alcohol-related negative consequences, controlling for drinks per week and sex. Findings failed to support significant differences in the effect of PBS use on alcohol-related negative consequences between students with vs. without ADHD ($b = -0.04, SE = 0.06, 95\% \text{ CI } [-0.17, 0.08], p = 0.50$). These findings were consistent with each PBS subscale, such that no significant interaction effect of ADHD x PBS was observed on alcohol-related negative consequences: MOD ($b = 0.01, SE = 0.24, 95\% \text{ CI } [-0.50, 0.50], p =$

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0.97), SLD ($b = -0.14$, $SE = 0.13$, 95% CI [-0.40, 0.12], $p = 0.30$), and SHR ($b = -0.06$, $SE = 0.14$, 95% CI [-0.34, 0.22], $p = 0.68$).

Discussion

This study examined differences in PBS use among heavy drinking college students with and without ADHD and between males and females. This study is the first to investigate PBS use in a sample of heavy drinking college students with a clinically diagnosed ADHD group matched with controls.

ADHD and sex differences in alcohol use and alcohol-related negative consequences

Results from descriptive analyses on alcohol use showed significant differences between males and females, but not ADHD and control groups. Males consumed almost twice as many drinks per week as females but showed no significant differences on binge drinking episodes and reported intoxication. The similarities between sex on binge episodes may be a result of the measure's criterion (i.e., 4+ [women] or 5+ [men] drinks in 2 hours or less), accounting for the epistemological factors (i.e., weight, metabolism of alcohol, fat storage) that often differentiate the number of drinks consumed between males and females (Erol & Karpyak, 2015; Wechsler et al., 1995). Thus, measures for risky alcohol use should continue to be calibrated for males and females in future research. Additionally, the number of alcoholic beverages a person consumed each week did not provide adequate information in assessing risk compared to also including frequency measures on binge episodes and intoxication. Thus, including measures of heavy drinking episodes rather than assessing weekly drinks alone provides a clearer picture in assessing risk for problematic drinking habits.

Contrary to our prediction, females in our study reported experiencing significantly more alcohol-related negative consequences than males. Although drinks were controlled for in this

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analysis, the result is surprising given how many more drinks per week males consumed compared to females. One potential explanation for this relationship could be engagement in unplanned heavy drinking episodes. Fairlie et al, (2019) found that females were more likely to engage in unplanned heavy drinking, and unplanned heavy drinking increased chances of experiencing alcohol-related negative consequences. We do not examine unplanned drinking in the current study, but Fairlie and colleagues' findings (2019) reveal an important future direction. Moving forward, investigation on drinking intentions vs. actual alcohol consumption in a heavy drinking sample such as ours is warranted. This information could uncover possible driving factors in the relationship between drink frequency and alcohol-related negative consequences in a heavy drinking sample.

Consistent with the literature, ADHD status was not significantly associated with alcohol use (i.e., drinks per week, frequency of intoxication, and number of binge drinking episodes; Elkins et al., 2018; Glass & Flory, 2012; Howard & Pritchard, 2017; Looby et al., 2019; Mesman, 2015). One prior study found that higher levels of ADHD predicted an increased frequency of binge drinking, but they did not assess this construct in an all-heavy drinking sample, nor did they control for sex in their binge episode measure (i.e., they used 5+ drinks in 2 hours or less for all participants; Garcia et al., 2020). Therefore, it is unknown if that study's findings are generalizable to females or a heavy drinking population. There is a consistent trend that males experience more binge episodes than females (Wilsnack et al., 2018), however, some findings suggest that in young adult males and females, binge drinking episodes are more comparable (Erol & Karpyak, 2015; Wechsler et al., 1995). This finding suggests that research on binge drinking episodes should account for sex as well as the developmental period of the sample. Future research should assess the relationship between ADHD and binge drinking

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episodes such as the contexts surrounding heavy drinking (e.g., school nights) to add to our limited understanding of the relationship between ADHD status and heavy drinking.

Despite no differences between students with vs. without ADHD on drinking variables, students with ADHD reported more alcohol-related negative consequences compared to their similarly-drinking peers. This finding replicates and extends prior work showing that students with ADHD do not necessarily consume more alcohol, yet they experience more negative consequences relative to peers (Glass & Flory, 2012; Mesman, 2015; Rooney et al., 2012). Given our study design where groups were virtually matched on drinking quantity and risk status, as well as sex, this is the most stringent test to date of the associations between ADHD, alcohol use, and alcohol-related negative consequences among high-risk drinkers with and without ADHD.

PBS Use

This is the first study to rigorously examine PBS use in a sample of heavy drinkers with and without ADHD. Consistent with our hypothesis, students with ADHD and males were less likely to use PBS than students without ADHD and females (when drinks per week were controlled). For students with ADHD, this finding may be due to an increased risk of poor self-regulation, which can impact the ability to make thoughtful decisions necessary to implement PBS (Shiels & Hawk, 2010). This study expands on the finding that self-regulation problems predict lower use of PBS (D'Lima et al., 2012) in a clinically diagnosed group of students with ADHD vs. non-ADHD peers. Beyond self-regulation, ADHD is a complex disorder, where multiple characteristics (i.e., emotion dysregulation, inattention) may also be interacting with PBS use. Given that individuals with ADHD underutilize PBS, future research should investigate which characteristics of ADHD play a part in the relationship between diagnosed ADHD and PBS use. Additionally, our finding that females utilize more PBS than males is consistent with

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previous work (Haines et al., 2006; Palmer et al., 2010; H. R. Treloar et al., 2014). This result has been interpreted to reflect on the competitive nature of drinking between males in college, where competitive drinking contradicts certain PBS items (Delva et al., 2004; Kenney & LaBrie, 2013; Palmer et al., 2010). On the other hand, females may use more PBS to manage or avoid a high-risk sexual experience (Palmer et al., 2010).

Additionally, students who consumed more weekly drinks were less likely to employ PBS than students who consumed fewer weekly drinks. This suggests that the more severe heavy drinkers are less likely to deploy PBS. This provides some implications on the limits to PBS use, where heavier drinkers may be at risk for underutilizing PBS.

Recognizing the importance of evaluating specific types of PBS, we explored subscales of PBS use and differences among student drinkers with versus without ADHD and between males/females. Students with ADHD and males were significantly less likely to employ MOD PBS compared to students without ADHD and females. The MOD subscale of PBS taps into strategies that require planning, foresight, and sacrifice in the moment of highly pleasurable social experiences (e.g., “Drink slowly, rather than gulp or chug”, “Avoid trying to ‘keep up’ or ‘out-drink’ others”, “avoid drinking games”; H. Treloar et al., 2015). These key ingredients nearly completely overlap with the core self-regulation deficits characteristic of ADHD (Barkley, 1997).

Males were less likely to use all three subscales of PBS (i.e., MOD, SLD & SHR) compared to females and students who consumed fewer weekly drinks. Items in the MOD and SLD (e.g., “determine not to exceed a set number of drinks”, “drink water while drinking alcohol”; H. Treloar et al., 2015) subscales align with forms of competitive drinking, which may contradict the competitive drinking culture evident to male college students. Moreover, the

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results from investigating PBS subscales reveals that males are consistently underutilizing PBS, and there is no single subscale that is the driving factor of the relationship with total PBS and sex. Furthermore, when assessing the PBS subscales among ADHD status, it appears that MOD may be the driving factor in total PBS use.

Interactive Effects: Sex, ADHD, PBS Use and Alcohol-Related Negative Consequences

To date, this is the first study to look at if clinically diagnosed ADHD symptoms moderate the relationship between PBS use and sex in college students. Inconsistent with our hypothesis, no significance interactions were found on the effects of ADHD moderating the relationship between sex on total PBS use. Taken together with the significant independent effects of sex and ADHD status, these findings suggest that male status may be at risk for underutilizing PBS regardless of ADHD status. Looby and colleagues (2019) found a protective factor in PBS use and ADHD symptoms, where individuals with more ADHD symptoms reported lower alcohol use when using PBS compared to students with fewer ADHD symptoms. Considering that quantity of alcohol use only plays a partial role in alcohol-related problems (Glass & Flory, 2012), we expanded upon this finding and assessed if ADHD status moderated the relationship between PBS use and alcohol-related negative consequences. No significant moderation was found, failing to support the “PBS protects the impaired” hypothesis (D’Lima et al., 2012). All in all, PBS may partially protect individuals with ADHD in drinking quantity and frequency, but not in reducing alcohol-related negative consequences.

Limitations

Despite the many strengths and novel approaches in this study, there are still limitations that should be noted. First of all, similar to most research involving PBS, this study was cross-sectional and cannot provide causal implications. A causal relationship between PBS and ADHD

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would greatly benefit interventions for college drinking in how to effectively approach education and prevention efforts to reduce negative alcohol outcomes. Secondly, considering that the PBSS-20 scale was designed to intervene with a normal drinking sample, the efficacy of PBS potentially reached the breadth of the intervention approaches required for a heavier drinking sample, such as in this one. Thirdly, in our sample, stimulant medication use was not accounted for, where some participants with ADHD may have had reduced deficits as a result, possibly impacting relationships between ADHD and drinking variables. Finally, these findings may not be generalizable to non-COVID times. Only a small number of participants ($n=11$) went through the entire study protocol in person before the onset of COVID-19 moved the study to be completely virtual. Some students moved back home during the pandemic, and all students, living on or off campus, were asked to follow CDC guidelines for social distancing, which could have affected parties and, consequently, the drinking habits of students. However, all students met at-risk drinking criteria upon being screened, and study personnel inquired about drinking routines, where students indicated if their drinking habits have been, and were planning to be, typical. Students who were asked to quarantine due to COVID were rescheduled until after they resumed their typical drinking routine. Therefore, study personnel did everything in their control to minimize the impact of the ongoing COVID-19 pandemic. For future research, it would be interesting to compare the reports of the participants across different time points of the study (i.e., before the pandemic, during the pandemic, when things started opening back up) to examine if there are any differences in levels of risk between heavy drinkers across the status of the pandemic.

Conclusion

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Students with ADHD are using less PBS, drinking similar amounts to their peers, and experiencing more alcohol-related negative consequences (unrelated to their use of PBS). Future research warrants investigating mechanisms (i.e., impulsivity, emotion dysregulation, delay discounting, drinking motives) to better understand why students with ADHD use less PBS yet experience more alcohol-related negative consequences. Understanding the mechanisms would provide direction in treatment and education to prevent negative alcohol-related negative consequences among college students with ADHD.

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Table 1. Descriptive Statistics and Bivariate Correlations among Key Study Variables

	ADHD	Sex	Binge	Intoxication	BYAACQ	PBS-T	PBS_SLR	PBS_MOD	PBS_SHR
ADHD	1	0.08	-0.06	0.07	0.27*	-0.24*	-0.15	-0.25*	-0.22*
Sex		1	0.13	0.15	-0.04	-0.47**	-0.35**	-0.42**	-0.41**
Binge			1	0.47**	0.28*	-0.22*	-0.11	-0.23*	-0.23*
Intoxication				1	0.34**	-0.22*	-0.17	-0.17	-0.20
BYAACQ					1	-0.25*	-0.18	-0.26*	-0.20
PBS-T						1	0.86**	0.78**	0.83**
PBS-SLD							1	0.57**	0.50**
PBS-MOD								1	0.53**
PBS-SHR									1
<i>M</i>	0.53	0.52	5.23	8.73	7.68	71.54	19.64	13.26	38.64
<i>SD</i>	0.50	0.50	3.65	4.96	4.76	14.29	6.85	3.90	6.43

Note. * $p < 0.05$, ** $p < 0.01$. ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Binge = 4+ or 5+ drinks in 2+ hours for females and males, respectively, BYAACQ-30 = brief young adult alcohol consequences questionnaire, PBS-T = protective behavioral strategies total score, PBS-SLD = protective behavioral strategies: stopping/limiting drinking, PBS-MOD = protective behavioral strategies: manner of drinking, PBS-SHR= protective behavioral strategies: serious harm reduction

Table 2a. Moderation Results ADHD * Sex

Model Summary: Outcome PBS-T							
	R	R ²	MSE	F	df1	df2	p
	.60	.36	135.77	10.54	4	75	< 0.0001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	87.89	3.19	27.53	< 0.001	81.53	94.25	
Sex	-12.16	4.03	-3.02	0.004	-20.19	-4.13	
ADHD	-7.84	3.79	-2.07	0.04	-15.38	-0.30	
Sex*ADHD	3.30	5.24	0.63	0.53	-7.14	13.75	
Weekly Drinks	-0.33	0.13	-2.62	0.01	-0.59	-0.08	

Note. ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies total score

Table 2b. Moderation Results ADHD * Sex

Model Summary: Outcome PBS-SLD							
	R	R ²	MSE	F	df1	df2	p
	.49	.24	37.10	6.00	4	75	< 0.001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	26.70	1.67	16.00	< 0.0001	23.37	30.02	
Sex	-5.26	2.11	-2.50	0.01	-9.46	-1.07	
ADHD	-3.73	2.0	-1.89	0.06	-7.67	0.21	
Sex*ADHD	3.74	2.74	1.36	0.18	-1.73	9.20	
Weekly Drinks	-0.17	0.07	-2.55	0.01	-0.30	-0.04	

Note. ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS-SLD= protective behavioral strategies: stopping/limiting drinking

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Table 2c. Moderation Results ADHD * Sex

Model Summary: Outcome PBS-MOD							
	R	R ²	MSE	F	df1	df2	p
	.57	.32	10.66	8.92	4	75	< 0.0001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	17.63	0.89	19.71	< 0.0001	15.85	19.41	
Sex	-3.26	1.13	-2.89	0.01	-5.52	-1.01	
ADHD	-2.50	1.06	-2.35	0.02	-4.61	-0.39	
Sex*ADHD	1.33	1.50	0.01	0.37	-1.59	4.26	
Weekly Drinks	-0.08	0.04	-2.36	0.02	-0.16	-0.01	

Note. ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies manner of drinking subscale

Table 2d. Moderation Results ADHD * Sex

Model Summary: Outcome PBS-SHR							
	R	R ²	MSE	F	df1	df2	p
	.50	.25	32.93	6.14	4	75	< 0.001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	43.57	1.57	27.71	< 0.0001	40.44	46.70	
Sex	-3.64	1.99	-1.83	0.07	-7.59	0.32	
ADHD	-1.61	1.86	-0.86	0.39	-5.32	2.10	
Sex*ADHD	-1.77	2.58	-0.68	0.50	-6.91	3.38	
Weekly Drinks	-0.08	0.06	-1.27	0.21	-0.21	0.05	

Note. ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies serious harm reduction subscale

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Table 3a. Moderation Results ADHD * PBS-T

Model Summary: Outcome BYAACQ							
	R	R ²	MSE	F	df1	df2	p
	.6046	.3655	14.9154	8.5256	5	74	< 0.0001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	2.85	4.17	0.68	0.5	-5.46	11.17	
PBS-T	0.004	0.5	0.09	0.93	-0.09	0.1	
ADHD	5.58	4.69	1.19	0.24	-3.76	14.92	
PBS-T*ADHD	-0.04	0.06	-0.68	0.5	-1.17	0.08	
Weekly Drinks	-0.23	0.04	5.15	0	0.14	0.32	
Sex	-2.69	1.03	-2.61	0.01	-4.75	-0.63	

Note. BYAACQ = brief young adult alcohol consequences questionnaire, ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies total score

Table 3b. Moderation Results ADHD * PBS-SLR

Model Summary: Outcome BYAACQ							
	R	R ²	MSE	F	df1	df2	p
	0.61	0.37	14.82	8.68	5	74	< 0.0001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	1.01	2.53	0.40	0.69	-4.03	6.05	
PBS-SLR	0.09	0.10	0.89	0.37	-0.11	0.29	
ADHD	5.29	2.73	1.93	0.06	-0.16	10.73	
PBS-SLR*ADHD	-0.14	0.13	-1.05	0.30	-0.40	0.12	
Weekly Drinks	0.24	0.04	5.40	< 0.0001	0.15	0.32	
Sex	-2.35	0.99	-2.40	0.02	-4.32	-0.38	

Note. BYAACQ = brief young adult alcohol consequences questionnaire, ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies total score

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Table 3c. Moderation Results ADHD * PBS-MOD

Model Summary: Outcome BYAACQ							
	R	R ²	MSE	F	df1	df2	p
	0.61	0.36	14.97	8.44	5	74	< 0.0001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	4.52	3.38	1.34	0.19	-2.22	11.25	
PBS-MOD	-0.09	0.21	-0.45	0.65	-0.49	0.31	
ADHD	2.25	3.40	0.66	0.51	-4.53	9.03	
PBS-MOD*ADHD	0.01	0.24	0.04	0.97	-0.47	0.49	
Weekly Drinks	0.23	0.04	5.24	< 0.001	0.14	0.32	
Sex	-2.78	1.03	-2.71	0.01	-4.83	-0.74	

Note. BYAACQ = brief young adult alcohol consequences questionnaire, ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies total score

Table 3d. Moderation Results ADHD * PBS-SHR

Model Summary: Outcome BYAACQ							
	R	R ²	MSE	F	df1	df2	p
	0.61	0.37	14.88	8.58	5	74	< 0.0001
Model							
	b	SE	t	p	LLCI	ULCI	
Constant	4.74	4.27	1.11	0.27	-3.76	13.24	
PBS-SHR	-0.04	0.10	-0.38	0.71	-0.24	0.16	
ADHD	4.63	5.51	0.84	0.40	-6.36	15.61	
PBS-SHR*ADHD	-0.06	0.14	-0.41	0.68	-0.34	0.22	
Weekly Drinks	0.23	0.04	5.38	< 0.001	0.15	0.32	
Sex	-2.89	1.02	-2.83	0.01	-4.92	-0.86	

Note. BYAACQ = brief young adult alcohol consequences questionnaire, ADHD = attention-deficit/hyperactivity disorder, Sex = male (0), female (1), Weekly Drinks = total weekly drinks reported on the Daily Drinking Questionnaire, PBS T = protective behavioral strategies total score