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# Gender Differences in the Relationships Among Major Depressive Disorder, Heavy Alcohol Use, and Mental Health Treatment Engagement Among College Students

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**ABSTRACT. Objective:** Although major depressive disorder (MDD) and heavy episodic drinking (HED, 4+/5+ drinks in a single sitting for women/men) are common among young adults in college, the relationship between the two remains unclear. This study examined the association between MDD and HED in this population, the effect of gender on this association, and whether comorbid MDD and heavy alcohol use are associated with higher rates of mental health treatment engagement. **Method:** The study comprised 61,561 (65.3% female) undergraduate students who answered an online survey on depression, alcohol use, and treatment engagement in the past year. Hierarchical linear regressions examined the association between MDD and alcohol use (HED and peak blood alcohol concentration [pBAC]) and whether gender moderated these associations. Logistic regressions were then conducted to exam-

ine the influence of MDD, heavy alcohol use, and gender on treatment engagement. **Results:** Students with MDD reported more frequent HED and higher pBAC than did students without MDD; this was especially true for female students. Rates of treatment engagement were higher among women than men, among students with MDD than students without MDD, and among female students with HED than women without HED. **Conclusions:** The presence of an association between MDD and heavy alcohol use suggests the need for systematic screenings of both conditions. Low rates of treatment engagement in college students with MDD and heavy alcohol use calls for the development of strategies to engage this high-risk group in treatment. (*J. Stud. Alcohol Drugs*, 77, 620–628, 2016)

APPROXIMATELY 40% OF COLLEGE STUDENTS report engaging in heavy episodic drinking (HED, defined as 4+/5+ drinks in a single sitting for women/men; Wechsler et al., 2001) at least once in the past 2 weeks, and 23% report engaging in HED at least three times in the previous 2 weeks (Wechsler & Nelson, 2008). Such heavy drinking takes a considerable toll: an estimated 1,800 deaths, 97,000 sexual assaults, and 599,000 injuries are attributable to alcohol use among college students on a yearly basis (Hingson et al., 2005, 2009). Alcohol is also associated with 66% of college suicides (the third leading cause of death

for young adults; Barrios et al., 2000). Given that there are approximately 20.6 million college students in the United States (Snyder & Dillow, 2015), it is crucial to determine factors contributing to HED and its sequelae in order to design better prevention and treatment strategies.

Major depressive disorder (MDD) is also common among college students, with prevalence rates ranging between 7% and 9% (Blanco et al., 2008; Eisenberg et al., 2013). In a nationwide survey, 32% of college students reported having felt “so depressed that it was difficult to function” at least once in the past year (American College Health Association, 2014, p. 15). Given the prevalence of heavy alcohol use and symptoms of depression in the college population, a considerable number of students report co-morbid MDD and heavy drinking (Cranford et al., 2009). Despite the common co-occurrence of MDD and alcohol use, it is still unclear whether one condition constitutes a risk factor for the other among young adults in college. The few studies that have examined the relationship between MDD and alcohol use have had mixed results. Dawson et al. (2005) observed an association between MDD and higher risk for alcohol dependence and HED among young adults (ages 18–29) not in college, yet not among young adults in college. Similarly, an

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investigation of 412 female undergraduate students did not find an association between depression and HED (here defined as consuming five or more drinks; Vickers et al., 2004). Moreover, in a previous study from our group, Cranford et al. (2009) found that, among 2,843 individuals (1,181 undergraduate and 1,662 graduate students), those with MDD had lower risk to engage in frequent HED than those with no depression. Findings regarding the association between nonclinical depressive symptoms and alcohol use are also mixed. Among college students, depressive symptoms have been found to be associated with ever engaging in HED (Valentiner et al., 2004), problematic alcohol use (Dvorak et al., 2013), and higher daily alcohol use (Pedrelli et al., 2011) but not with past-month drinking days (Lamis et al., 2010), drinks per month (Gonzalez et al., 2011), weekly drinks (Kenney et al., 2013), and frequent heavy drinking (Lamis et al., 2010; Vickers et al., 2004).

These mixed findings may be attributable in large part to three factors. First, several studies have combined undergraduate and graduate students (Cranford et al., 2009; Dawson et al., 2005), although heavy drinking is significantly more prevalent among undergraduate students (Cranford et al., 2009). Second, previous studies with college students have exhibited considerable variability in which drinking behaviors they have examined to be associated with depression. For example, some studies have examined presence of any heavy drinking, some frequency of heavy drinking, and some number of weekly drinks. A study of 14,000 individuals from 18 to 76 years old found that the associations between depression and alcohol use varied based on the drinking behavior considered. For example, depression was associated with both past-year typical quantity of alcohol use and frequency of HED but not with past-year frequency of any alcohol consumption or annual volume of alcohol consumed (Graham et al., 2007). Moreover, current definitions of heavy drinking (consumption of 4/5 drinks for women/men in a row or consumption of 4/5 drinks for women/men within 2 hours; National Institute on Alcohol Abuse and Alcoholism, 2004) are limited by not accounting for the individual's weight, and thus may not accurately measure the actual degree of alcohol intoxication (see Borsari et al., 2001).

Third, and most important, many studies with college students have not examined gender effects in the association between depression and heavy drinking. Compared with female college students, higher numbers of male students meet criteria for alcohol abuse and dependence, engage in HED (Harford et al., 2006; Wechsler et al., 1994), endorse higher alcohol consumption (O'Donnell et al., 2006; Wechsler et al., 1994; White et al., 2006), and report more alcohol-related problems (Geisner et al., 2004; Harrell & Karim, 2008). Furthermore, women and men metabolize alcohol differently, which may lead to different blood alcohol levels even when consuming the same amount of alcohol (Thomasson, 1995). However, depressive symptoms are more common in female

than male students (Harford et al., 2006; Weitzman, 2004). Preliminary evidence suggests that gender may moderate the relationship between depressive symptoms and drinking behavior. In college students, men have demonstrated a stronger relationship between psychological distress and weekly alcohol consumption than women (Geisner et al., 2004), and a relationship between weekend elevated sadness and subsequent elevated weekday alcohol use was found in male but not female college students (Hussong et al., 2011). Conversely, Cranford et al. (2009) found that the risk for frequent HED among male students with MDD was lower than that for female students with MDD. These findings highlight the need for more in-depth analysis of the effect of gender on the association between depression and heavy alcohol use in college students.

Engagement in mental health treatment is very relevant for students experiencing depressive symptoms and HED. Heavy alcohol use is associated with significant impairment in functioning, and the presence of co-occurring depressive symptoms is associated with an even higher risk for alcohol-related problems (Camatta & Nagoshi, 1995; Dennhardt & Murphy, 2011; Harrell & Karim, 2008; Weitzman et al., 2004). Although between one third and one half of the students reporting only mood problems are engaged in treatment, very few (5%–13%) students with only HED are in treatment (Blanco et al., 2008; Cranford et al., 2009). However, the proportion of students with both HED and MDD who are in treatment remains unknown. One study found that among heavy drinking students, depressive symptoms are associated with higher informal (talking to a friend) and formal (talking with a counselor or medical provider) help seeking (Buscemi et al., 2010). However, the study examined formal and informal help seeking together. Moreover, although a higher proportion of female than male students seek treatment for any disorder (Eisenberg et al., 2011a), it is unclear whether similar gender differences exist among students with co-occurring depression and HED. Information on the proportion of students with co-occurring MDD and HED receiving mental health treatment may be of importance for outreach programs.

The current study examined two related research questions in a large, multisite sample of undergraduate students. First, we aimed to investigate the association between MDD and heavy alcohol use as well as peak blood alcohol concentration (pBAC) among undergraduate students and the effect of gender on these associations. We also addressed limitations of previous research by measuring both heavy alcohol use and pBAC (a method that accounts for weight and gender; Thomasson, 1995). We hypothesized that students with MDD would drink more (have both more frequent HED and higher pBAC) than those without MDD. Consistent with previous research examining MDD (Cranford et al., 2009), we hypothesized that the association between depression and heavy alcohol use and pBAC would

be stronger in women. Second, we examined the effect of MDD, heavy alcohol use, and gender on mental health treatment use among students. As previously noted, this is an important question that, to our knowledge, has not yet been examined. Given previous studies suggesting a higher help-seeking behavior among women and among students with co-occurring heavy drinking and depressive symptoms, we hypothesized that students with comorbid MDD and HED would engage in mental health treatment significantly more than those with only MDD and that this association would be stronger among women.

## Method

### *Study design*

This study is a secondary analysis of multiyear cross-sectional data from the Healthy Minds Study (HMS; Eisenberg et al., 2007) for college and university student populations in the United States. HMS is an annual web-based survey that examines mental health and service utilization; data were drawn from six waves of HMS (2007, 2009–2013).

### *Participants*

The current study examines a sample of undergraduate students ( $N = 61,561$ ) enrolled at more than 100 institutions. In 2007 and 2009, a random sample of 1,000 students at each institution was invited via postal mail (with a \$2 incentive) followed by email reminders. Since 2010, recruitment has been conducted entirely by email, with random samples of 4,000 students at larger institutions and full student populations at institutions with fewer than 4,000 students. All students were informed that they were entered into a cash sweepstakes regardless of their participation. To engage nonresponders, up to three reminders were sent over the monthlong data collection period. Response rates ranged from 23.2% to 42.7% over the 7-year span of 2007 to 2013. The survey was administered using DatStat Illume online survey software (DatStat, Inc., Seattle, WA). The study was approved by the Institutional Review Boards at all participating institutions. Students were presented with an online consent form and voluntarily granted consent before entering the survey.

To adjust for potential differences between survey responders and nonresponders, we constructed sample probability weights. For students in the initial random samples, we obtained administrative data from participating institutions, including gender, academic level, race/ethnicity, and grade point average. We then constructed response weights, equal to 1 divided by the predicted probability of survey response, using a logistic regression to estimate the predicted probability of response based on these variables. Thus, weights are larger for respondents with underrepresented

characteristics, ensuring that all estimates are representative of the full population in terms of basic demographic and other characteristics. This method follows the approach used in the National Comorbidity Survey Replication to develop a nonresponse adjustment weight (Kessler et al., 2004). Nonresponse weights to adjust for nonresponse bias have been used by other epidemiologic surveys of mental health and substance use (Grant et al., 2004; Substance Abuse and Mental Health Services Administration, 2007).

### *Measures*

*Depressive symptoms.* MDD was measured using the Patient Health Questionnaire–9 (PHQ-9), a validated screening instrument based on the core symptoms of a major depressive episode (Spitzer et al., 1999). The instrument yields individual scores ranging from 0 to 27, with higher number indicating more severe depressive symptoms. Validation studies of the PHQ-9 have shown the instrument to be internally consistent and highly correlated with clinical diagnosis of MDD (Diez-Quevedo et al., 2001; Löwe et al., 2004; Manea et al., 2015), and it has shown high internal consistency in previous research ( $\alpha = .84$ ; Eisenberg et al., 2011b) and in the present sample ( $\alpha = .87$ ). In the current study, we categorized presence of MDD using the cutoff score of PHQ-9 equal to 10, which has been shown to have adequate sensitivity and specificity for diagnosing MDD (Kroenke et al., 2001; Manea et al., 2015; Manea et al., 2012).

*Alcohol use.* HED was measured based on responses to a question inquiring about frequency of consumption of four or five drinks or more in a row during the past 2 weeks for women and men, respectively. Response options included *zero, one time, two times, three to five times, six to nine times, and ten or more times*. A subsample ( $n = 13,316$  from the 2012 and 2013 HMS) was also asked about the number of drinks they had in a row during the most recent HED episode. The eight response options were *4 or 5 drinks (for women and men, respectively), 5 drinks, 6 drinks, 7 drinks, 8 drinks, 9 drinks, 10–14 drinks, and 15 or more drinks*. Because the data set included the specific number of drinks consumed during the most recent heavy drinking episode, gender, the amount of time spent drinking, and the participant's body weight, we were able to calculate a pBAC using the Matthews and Miller (1979) equation and an average metabolism rate of .017 g/dl per hour. This approach has been used in our previous research (Borsari et al., 2012) and is recommended above other drinking indices when gender differences are being examined (Borsari et al., 2001).

*Treatment engagement.* Participant engagement in mental health treatment was measured by the following dichotomous (yes/no) item: "In the past 12 months have you received counseling or therapy for your mental or emotional health from a health professional (such as psychiatrist, psychologist, social worker, or primary care doctor)?"

*Data analysis*

We first examined the association between MDD and alcohol use by conducting equivalent hierarchical linear ordinary least squares regression models for HED and pBAC. Each model was constructed using three steps. In the first step, the covariates age, race/ethnicity (White vs. non-White), citizenship, maternal education (a proxy for socioeconomic status), and gender were entered. In the second step, we added a binary measure of MDD status (positive/negative screen on PHQ-9). In the third step, we added an interaction term of gender and MDD status. We then conducted a hierarchical logistic regression to examine the associations among MDD, alcohol use, and gender on treatment utilization. The first step included covariates from the ordinary least squares regression models. The second step added measures of MDD status (absence/presence) and any HED (binary variable indicating presence of any HED). The third step added terms of two-way interaction of gender and MDD, gender and HED, and MDD and HED. The fourth step added a three-way interaction of gender, MDD status, and HED. We then conducted post hoc analyses by examining marginal effects. Models were adjusted for survey nonresponse, using the weights described above. All analyses were conducted using Stata 12 (StataCorp LP, College Station, TX). We conducted post hoc analyses and computed marginal effects to examine significant interaction terms.

**Results**

*Sample characteristics*

The sample comprised 61,561 undergraduate students (65.3% female; Table 1). The majority of the sample was White (74.3%) and between 18 and 22 years old (82.3%). Overall, 46.0% (50.3% male, 42.8% female) of students reported at least one episode of HED during the past 2 weeks, and 24.1% of the sample screened positive for MDD, with rates significantly higher among women (25.8%) relative to men (21.9%). Co-occurring MDD and HED in the previous two weeks was present in 11.6% of the participants (11.7% of females, 11.4% of males).

*Relationships between heavy episodic drinking, peak blood alcohol concentration, major depressive disorder, and gender*

In the hierarchical linear regression models exploring relationships between frequency of HED, MDD, and gender (Table 2, left panel), we found that gender and MDD, but not their interaction, were significant predictors of HED frequency. Significantly more variance was explained when MDD was added along with gender to the model ( $\Delta R^2 = .0032$ ).

Hierarchical linear regression models exploring the relationships between pBAC, MDD, and gender (Table 2, right

TABLE 1. Demographic and clinical variables ( $N = 61,561$ )

Variable	Men ( $n = 21,346$ ) %	Women ( $n = 40,215$ ) %	F or $\chi^2$
<b>Demographics</b>			
Age, in years			
18	10.3	12.4	28.5***
19	18.6	20.1	
20	18.5	19.9	
21	19.1	20.9	
22	13.3	11.0	
23–25	10.4	7.4	
26–30	5.2	3.5	
31–35	1.9	1.5	
36–40	1.1	1.1	
≥41	1.6	2.1	
Race/ethnicity			
Latino	7.9	8.3	2.2
Non-Latino	92.1	91.7	
White	75.0	73.7	
Non-White	25.0	26.3	
Depression			
PHQ-9	21.9	25.8	70.1***
Alcohol use			
HED	50.3	42.8	200.8***
pBAC	82.0	85.7	102.1***

Notes: PHQ-9 = Patient Health Questionnaire (9 item)  $\geq 10$ ; HED = any heavy episode drinking in past 2 weeks; pBAC = peak blood alcohol concentration  $> .08$  g/dl.  
\* $p \leq .05$ ; \*\*\* $p < .001$ .

panel) indicated that gender, MDD, and their interaction were all significant predictors of pBAC and that each step explained significantly more variance. Post hoc analyses of average marginal effects showed that women with MDD had .009 g/dl higher pBAC than women without MDD ( $p < .001$ ), compared with a .004 g/dl higher pBAC for men with MDD relative to men without MDD ( $p < .001$ ; Figure 1).

*Relationships between treatment utilization, heavy episodic drinking, major depressive disorder, and gender*

In the hierarchical logistic regressions examining treatment engagement in the past year (Table 3), women and students with MDD had significantly increased odds of treatment utilization. Post hoc analyses of the significant interaction of gender and HED revealed that the difference in proportion of students with and without MDD having engaged in mental health treatment was higher in women (31.1% vs. 15.8%,  $p < .001$ ) than in men (23.8% vs. 9.9%,  $p < .001$ ). Similarly, the difference between students with and without HED who engaged in treatment was higher among women (21.3% vs. 18.6%,  $p < .001$ ) than among men (12.8% vs. 13.2%,  $p = .16$ ).

**Discussion**

The current study revealed several unique and important associations among gender, MDD, HED, and mental health

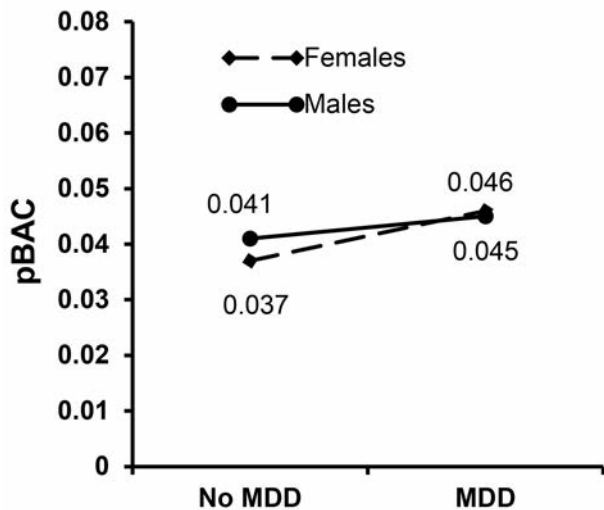


FIGURE 1. Peak blood alcohol concentration (pBAC) and major depressive disorder (MDD) in female and male students

treatment utilization among college students. First, college students with MDD reported higher frequency of HED and higher levels of alcohol intoxication. Second, the association between MDD and higher alcohol intoxication during a heavy drinking episode was stronger in female than male students; in contrast, both men and women reported a similar degree of association between MDD and frequency of HED. Third, although there was no difference in rates of treatment utilization between depressed students with and without HED, we found that students with MDD were more likely to be engaged in mental health treatment, especially women. Last, we also observed that a higher proportion of female students with HED than female students without HED were engaged in treatment. Of interest, the opposite association was evident in male students. To our knowledge, this is the first time the prevalence of treatment engagement among female and male students reporting HED has been reported.

Together, these findings have significant theoretical, clinical, and research implications.

The link between depression and alcohol use (both HED and pBAC) is particularly concerning given that HED is associated with severe consequences, and a higher frequency of this behavior increases the risk of problems (Mundt et al., 2009). Although our study found small effects for the associations between MDD and HED, MDD and pBAC, and the gender interaction, when considering that there are 20.6 million college students in the United States (Snyder & Dillow, 2015), even a small increase in frequency of HED or alcohol intoxication has significant public health implications. Indeed, a number of studies have established that even small differences in HED frequency or in pBAC may increase the risk for alcohol-related problems in meaningful ways. Students with frequent heavy drinking (three or more occasions per week) report experiencing more than twice as many alcohol-related problems than nonfrequent heavy drinking students on average over the course of a year (27.7 + 5.9 vs. 11.8 + 12.9, respectively; Presley & Pimentel, 2006) and are five times as likely to experience five or more alcohol-related problems (Wechsler et al., 1994). Female students are 10% more likely to suffer an alcohol-related injury with each additional day consuming five or more drinks, and male students are 19% more likely to suffer an alcohol-related injury with each additional day consuming eight or more drinks (Mundt et al., 2009). Students who consume just two more drinks over what is considered heavy drinking (6/7 women/men) experience an average of more than three additional unique types of consequences in a year relative to those who consume the exact amount considered HED (using 4/5 definition for women/men; Read et al., 2008).

Similarly, higher BAC has been associated with higher risk for alcohol-related problems (Carey & DeMartini, 2010), and an increase of just .01 g/dl of daily blood alcohol level is associated with a 2% increase in the odds of aggressive behavior (Quinn & Fromme, 2011). We conducted follow-up analyses to better interpret our findings among

TABLE 2. Associations of gender and major depressive disorder (MDD) with heavy episodic drinking (HED) and peak blood alcohol concentration (pBAC)

Variable	HED				pBAC			
	$\beta$	<i>t</i>	$R^2$	$\Delta R^2$	$\beta$	<i>t</i>	$R^2$	$\Delta R^2$
Step 1			.0409	–			.0486	–
Gender	-.26***	-17.79			-.004***	-4.39		
Step 2			.0440	.0032***			.0548	.006***
Gender	-.27***	-18.20			-.004***	-4.80		
MDD	.17***	10.04			.01***	7.18		
Step 3			.0440	.0000			.0553	.0005*
Gender	-.26***	-16.40			-.005***	-5.38		
MDD	.18***	5.48			.005***	3.56		
Gender $\times$ MDD	-.01	-0.29			.004*	2.02		

Notes: Models control for age, race (White vs. non-White), citizenship, and maternal education. MDD = major depressive disorder, based on a Patient Health Questionnaire-9 score greater than 10.

\* $p \leq .05$ ; \*\*\* $p < .001$ .

TABLE 3. Multiple logistic regressions testing the associations of gender, depression, and heavy episodic drinking (HED) with treatment engagement

Variable	OR	<i>t</i>	<i>F</i>
Step 1			118.79***
Gender	1.71***	17.23	
Step 2			528.20***
Gender	1.68***	16.26	
MDD	2.68***	32.49	
HED (any)	1.00	-0.14	
Step 3			5.49***
Gender	1.62***	9.67	
MDD	2.93***	16.63	
HED (any)	0.87*	-2.42	
Gender × MDD	0.84*	-2.59	
Gender × HED	1.21**	3.03	
MDD × HED	1.04	0.67	
Step 4			1.88
Gender	1.58***	8.34	
MDD	2.77***	12.43	
HED (any)	0.83**	-2.73	
Gender × MDD	0.92	-0.88	
Gender × HED	1.29**	3.30	
MDD × HED	1.17	1.39	
Gender × MDD × HED	0.83	-1.37	

Notes: Models control for age, race (White vs. non-White), citizenship, and maternal education. OR = odds ratio; MDD = major depressive disorder. \**p* ≤ .05; \*\**p* < .01; \*\*\**p* < .001.

female students and found that during a heavy drinking episode, 22.9% of those with MDD relative to 16.5% of those without MDD had pBAC higher than .08 g/dl (considered the legal limit to drive in many U.S. states) and that 7.5% of those with MDD relative to 4% of those without MDD had a pBAC higher than .13 g/dl (corresponding to significant impairment).

The association of MDD and HED in both men and women contrasts previous research that reported that college students with MDD, especially men, had lower odds of frequent HED (Cranford and al., 2009). This discrepancy could be because Cranford and colleagues (2009) used a binary variable and examined the odds of the presence of frequent HED (HED at least three times in the past 2 weeks), whereas we examined frequency of HED in the past 2 weeks with the possibility of six responses (0, 1 time, 2 times, 3–5 times, 6–9 times, and 10 or more times). This possibility, combined with our previous research indicating that depressive symptoms are associated with daily drinking more in men than in women (Pedrelli et al., 2011), highlights the need for conducting systematic and detailed (not dichotomous yes/no) assessments of heavy alcohol use among students with MDD who may present at health centers or counseling centers. Only a minority of colleges conducts screenings for alcohol misuse (Winters et al., 2011), indicating a need for universities to increase their efforts to identify this risky behavior. Furthermore, on the basis of this study’s findings, counselors may educate students who have MDD about their increased risk for HED and, similarly, inform students with HED about their risk of developing MDD. Future studies may investigate

the direction of the association between MDD and HED and evaluate whether stopping HED may reduce MDD.

Regarding mental health treatment engagement, our findings replicate previous research indicating that female students were more likely than male students to be engaged in mental health treatment and that the association between MDD and treatment engagement was stronger in female than male students (Eisenberg et al., 2011a, 2013; Hasin et al., 2005). Perhaps the most compelling finding was that a higher proportion of female students with HED were engaged in treatment than female students without HED, a pattern that was not present in male students. One possible explanation for this pattern of findings is that female students who engage in HED may find alcohol-related incidents more aversive than men, and thus they may be more likely to engage in treatment to prevent these problems from happening. Among students who receive a sanction for an alcohol violation, avoiding another sanction is more important for females than for males, and females are more confident in their ability to do so than their male peers (Carey & DeMartini, 2010). Moreover, women perceive their friends as less approving of an alcohol violation than do men (Carey & DeMartini, 2010).

Degree of aversiveness to an alcohol-related problem also predicts change in alcohol behaviors (Barnett et al., 2006; Qi et al., 2014); women rate alcohol-related problems as more aversive than men (Qi et al., 2014) and following an alcohol-related incident may have higher motivation to change drinking behaviors than men. Conversely, male students with HED may not experience alcohol-related problems as aversive and thus may not be interested in treatment. Unexpectedly, students with MDD and HED did not have higher rates of mental health treatment utilization than students with MDD alone. Our results, together with a previous report that found that students with HED and depressive symptoms sought higher formal and informal help-seeking behaviors than their peers with only depression (Buscemi, 2010), suggest that college students with MDD and HED may engage in more informal help seeking than students with MDD alone but not in more formal treatment.

Given the cross-sectional nature of the presented findings, the temporal relationships between MDD and alcohol use can be interpreted in two ways. On the one hand, among undergraduate students, heavy drinking may lead to MDD. Indeed, alcohol is a depressant, and it has been shown that in some people depression can be induced by heavy alcohol use (Schuckit et al., 2013). Moreover, students who consume more alcohol and engage in more frequent heavy drinking are at higher risk for experiencing alcohol-related consequences (e.g., academic or relationship difficulties) that may lead to MDD. Heavy alcohol use may lead to difficulties with sleep (Chan et al., 2015) that, in turn, may lead to depression (Hershner & Chervin, 2014; Kenney, 2013). The gender effect of MDD on pBAC may be the result of women

and men metabolizing alcohol differently, which may contribute to the higher prevalence of depression in women.

On the other hand, it is possible that, consistent with the “self-medication” model (Khantzian, 2003), students with MDD may consume more alcohol and consume it more often to cope with their negative affect. Our finding of high pBAC among students with MDD suggests that students with MDD may consume more alcohol to reach a higher level of intoxication to cope with negative affect. The college years are characterized by numerous difficulties, as young adults attending college find themselves taking on more adult-like responsibilities and tasks without having yet mastered the skills and cognitive maturity of adulthood (Arnett, 2000). In this context, some develop MDD and may drink heavily because they lack alternative, healthy skills to cope with their depressed mood. In support of this hypothesis, it has been consistently shown that drinking to cope is associated with higher alcohol consumption during sad days (Grant et al., 2009). This self-medication model has received support in the context of posttraumatic stress disorder and alcohol use among college students (e.g., Read et al., 2014) and it may also explain HED in undergraduate students with depression. Future studies should seek to discern which of the above scenarios might explain the association we observed in this study.

### Limitations

The findings of this study should be considered in the context of some limitations. First, self-report assessments may be associated with biases; however, there is little indication that college students misrepresent alcohol use or other problems as long as confidentiality is clearly explained (Borsari & Muellerleile, 2009). Second, our computation of pBAC may have led to imprecise estimates because there may be individual variation in metabolism and because the response options for number of drinks consumed during a heavy drinking episode included both precise numbers and ranges of numbers. In addition, we used a cutoff score of 10 on the PHQ-9 to indicate MDD, whereas others have used a different algorithm. In our study, approximately 25% of the women and 21% of the men met criteria for MDD. These rates are higher than those found in previous studies that have reported that MDD was present in approximately 10% of students (Blanco et al., 2008; Eisenberg et al., 2013). However, Eisenberg and colleagues (2013) found that 17% of college students had MDD or minor depression (dysthymia or depression not otherwise specified). Moreover, a nationwide survey on college students found that 32% of college students reported having felt “so depressed that it was difficult to function” at least once in the past year (American College Health Association, 2014). It is possible that our cutoff score of PHQ-9 equal to 10 may have included students with MDD as well as with minor depres-

sion. We opted to use this cutoff score because it has shown to be more sensitive to MDD diagnoses than other methods (e.g., the PHQ-9 algorithm; Manea et al., 2015). Third, a response rate of approximately 25% of potential students who answered the survey may have introduced biases into the data. In an attempt to address survey nonresponse, we have constructed sample probability weight that would account for demographic differences between responders and non-responders. However, the probability weight may have not addressed other possible sampling biases. Last, we did not ask which condition students received mental health treatment for, and thus it is not possible to determine whether students were in treatment for heavy alcohol use or for other problems.

### Summary

These findings significantly increase our knowledge regarding the intersection of gender, MDD, heavy alcohol use, alcohol intoxication, and engagement in mental health treatment in college students. Specifically, depression and alcohol use differ in male and female college students, indicating the importance of continuing to consider gender when constructing and interpreting models of alcohol consumption. Of particular concern, only 29.5% of students with both MDD and HED received mental health treatment in the previous year, suggesting that there may be a large proportion of students at high risk who are not receiving formal help. Such low rates of engagement in mental health treatment highlight the need to increase screening and outreach efforts in college students.

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