



# Substance use behaviors, mental health problems, and use of mental health services in a probability sample of college students

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## ABSTRACT

This research examined 1) the prevalence of substance use behaviors in college students, 2) gender and academic level as moderators of the associations between mental health problems and substance use, and 3) mental health service use among those with co-occurring frequent binge drinking and mental health problems. As part of the Healthy Minds Study, a probability sample of 2843 college students completed an Internet survey on mental health problems, substance use behaviors, and utilization of mental health care. Response propensity weights were used to adjust for differences between respondents and non-respondents. Major depression, panic disorder, and generalized anxiety disorder were positively associated with cigarette smoking. Frequent binge drinking was negatively associated with major depression and positively associated with generalized anxiety disorder, and these associations were significantly stronger for males than females. Among students with co-occurring frequent binge drinking and mental health problems, 67% perceived a need for mental health services but only 38% received services in the previous year. There may be substantial unmet needs for treatment of mental health problems and substance use among college students.

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## 1. Introduction

The prevalence rates of substance use behaviors such as tobacco, alcohol, and marijuana use have been well documented among undergraduate students (ACHA, 2007; Mohler-Kuo, Lee, & Wechsler, 2003; Wechsler, Lee, Kuo, Seibring, Nelson, & Lee, 2002). Compared to their non-college attending peers, college students show lower levels of marijuana use and cigarette smoking, but higher levels of heavy drinking (Johnston, O'Malley, Bachman, & Schulenberg, 2007; SAMHSA, 2007). However, the extent to which substance use behaviors co-occur with mental health problems among college students is not well understood. Further, while numerous studies have focused on undergraduate students, few studies have examined the prevalence and co-occurrence of substance use behaviors and mental health problems in graduate students (cf. Gassman, Demone, & Wechsler, 2002). In addition, the implications of co-occurring substance use and mental health problems for use of mental health services among college students are unknown. Such information is critical for the design of prevention and intervention efforts as colleges continue to grapple with risky behaviors such as heavy drinking.

The negative effects of substance use behaviors are exacerbated by co-occurring psychiatric disorders, and recent studies have examined the associations between substance use behaviors and mental health problems among college students (Dawson, Grant, Stinson, & Chou, 2004; Kushner & Sher, 1993; Kushner, Sher, & Erickson, 1999; cf. Baer, 2002). Co-occurrence in college students and other understudied populations has been identified as a research priority (O'Brien et al., 2004), and the utility of such research for prevention and intervention efforts will be enhanced if subgroup differences in the prevalence and co-occurrence of substance use and mental health problems can be identified. In this research we examined gender and academic level (i.e., undergraduate vs.

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graduate student) differences in the prevalence of substance use behaviors and their associations with mental health problems. We focused on gender because epidemiologic studies of the U.S. population show that, compared to females, males have higher rates of tobacco use and nicotine dependence (Falk, Yi, & Hiller-Sturmhofel, 2006); alcohol involvement, including alcohol abuse and dependence (Chen, Dufour, & Yi, 2004; Grant et al., 2004); and marijuana use, abuse, and dependence (Compton, Grant, Colliver, Glantz, & Stinson, 2004). The higher rates of tobacco, alcohol, and marijuana use for males are also found in college student samples (Johnston et al., 2007). By contrast, lifetime and past 12-months prevalence rates of mood and anxiety disorders are higher for females compared to males (Grant et al., 2005; Hasin, Goodwin, Stinson, & Grant, 2005).

We also focused on academic level (undergraduate vs. graduate) for several reasons. As noted earlier, the vast majority of research on college students' substance use has focused on alcohol involvement among undergraduates (e.g., Ham & Hope, 2003). Of the five national studies on college student substance use, O'Malley and Johnston (2002) reported that only one (the CORE survey; Presley & Pimentel, 2006) surveys graduate students. Thus, documentation of prevalence rates of substance use among graduate students would be useful in determining service needs for this subpopulation.

Accordingly, the present study addressed three primary questions: 1) What is the prevalence of substance use behaviors in college students, overall and by gender and academic level (undergraduate vs. graduate)? 2) How are substance use behaviors associated with mental health problems and, do these patterns of co-occurrence vary by gender and/or academic level? 3) What proportion of students with a particularly risky type of co-occurrence – frequent binge drinking and mental health problems – receive mental health services? Below we briefly review the literature on the associations between mental health and smoking, alcohol involvement, and marijuana use with a focus on studies of college students.

### *1.1. Mental health and cigarette smoking*

Results from the National Survey on Drug Use and Health (NSDUH; SAMHSA, 2007) and the Monitoring the Future study (Johnston et al., 2007) showed that college students have lower smoking rates than their same-age non-college peers. Epidemiologic studies have found evidence for strong associations between nicotine dependence and mood and anxiety disorders (Breslau, 1995; Breslau, Kilbey, & Andreski, 1991; Grant, Hasin et al., 2004; Hagman, Delnevo, Hrywna, & Williams, 2008; see Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007, for a review of research on anxiety and smoking). Further, these associations appear to vary by gender. For example, Husky, Mazure, Paliwal, and McKee (2008) used data from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) and found that prior smoking, occasional smoking, and daily smoking were significantly related with current major depression, and these associations were stronger for women than men (cf. Breslau, 1995). Evidence for associations between cigarette smoking and symptoms of anxiety and depression in college samples has also been reported (Lenz, 2004; Saules et al., 2004; for a review see Patterson, Lerman, Kaufmann, Neuner, & Audrain-McGovern, 2004). However, to our knowledge, no studies have tested the hypothesis that gender and/or academic level moderate the associations between mental health problems and smoking in college samples.

### *1.2. Mental health and alcohol involvement*

Heavy alcohol use among college students has been identified as a major public health problem (Ham & Hope, 2003; Hingson, Heeren, Winter, & Wechsler, 2005). Compared to their non-college attending peers, college students have higher rates of past-month alcohol use (SAMHSA, 2007), binge drinking (Dawson et al., 2004; SAMHSA, 2007; Slutske, 2005; Slutske et al., 2004), and alcohol abuse (but not dependence; Slutske, 2005). Several studies have focused on the relationship between alcohol consumption and mental health problems among college students, but results have been mixed (see Ham & Hope, 2003). For example, Weitzman (2004) analyzed data from the 1997 and 1999 College Alcohol Study (CAS) and found that a measure of "poor mental health" was associated with increased odds of meeting criteria for alcohol abuse. Similarly, Stewart, Zvolensky, and Eifert (2001) reported positive correlations between anxiety sensitivity and frequency of heavy drinking episodes. Yet, in some studies alcohol involvement is associated with lower levels of anxious and depressed mood (Harrell & Karim, 2008; Hartley, Elsabagh, & File, 2004). For example, Ham and Hope (2005) found a negative association between social anxiety and weekly alcohol consumption among students referred to an alcohol intervention. Finally, recent evidence from the NESARC indicated that associations between mental disorders and alcohol involvement among college students emerged only for alcohol dependence (Dawson, Grant, Stinson, & Chou, 2005). The present study aims to clarify the relationship between alcohol use and mental health problems among college students by examining gender and academic level as possible moderators of this association.

### *1.3. Mental health and marijuana use*

As noted earlier, college students show slightly lower rates of marijuana use than their non-college peers (Johnston et al., 2007). Longitudinal and cohort studies of the general population have yielded mixed results in terms of the associations between marijuana use and depression, depressed mood, and anxiety (e.g., Harder, Morral, & Arkes, 2006; see Moore et al., 2007, for a review). However, depression has a consistent positive association with frequent marijuana use (Degenhardt, Hall, & Lynskey, 2003). Some studies of college students have also found evidence for a direct association between depressed mood and cannabis problems (Buckner, Keough, & Schmidt, 2007). By contrast, Stewart, Karp, Pihl, and Peterson (1997) found lower levels of anxiety sensitivity among college student marijuana users. These mixed results highlight the importance of examining possible moderators of the associations between mental health problems and marijuana use.

## 1.4. Summary

Although depression and anxiety showed strong and consistent associations with cigarette smoking, the evidence linking mental health and alcohol and marijuana use among college students is less consistent. To our knowledge, no studies have yet examined how the co-occurrence of mental health problems and substance use behaviors varies by gender and academic level. The examination of these sub-group differences has important implications for targeting interventions aimed at reducing substance use behaviors and mental health problems. The present study was designed to address this gap in our knowledge by examining three questions: 1) What is the prevalence of substance use behaviors in college students, overall and by gender and academic level (undergraduate vs. graduate)? 2) How are substance use behaviors associated with mental health problems, and do these patterns of co-occurrence vary by gender and/or academic level? 3) What proportion of students with a particularly risky type of co-occurrence – frequent binge drinking and mental health problems – receive mental health services?

One of the challenges for research on co-occurring substance use and mental health problems is the possibility that any observed patterns of covariation are spurious, i.e., attributable to some other factor(s). Indeed, developmental models of co-occurring psychiatric and substance use disorders include the *common factors model*, whereby both disorders are caused by a common risk factor (e.g., common genetic predisposition or environmental factors leading to AUD and depression; Li, Hewitt, & Grant, 2004; Swendsen & Merikangas, 2000; cf. Krueger & Markon, 2006). Thus, in analyses of associations between mental health problems and substance use, we statistically controlled for several demographic variables that have been established as correlates or risk factors for mental health problems and/or substance use, including race/ethnicity, living arrangement, and marital status. We also statistically controlled for several proximal and distal stressors, including current financial situation, past financial situation, and self, family, or friends' exposure to hurricane Katrina.

## 2. Methods

### 2.1. Participants

Our sample was based on an Internet survey of students attending a large, Midwestern, public university in fall 2005. The student population at this university approximates the demographic characteristics – in terms of race/ethnicity and gender – of the national population of college students (Eisenberg, Golberstein, & Gollust, 2007), although the university, as a large, research oriented institution, may not be representative in other respects. We randomly selected 5021 students (2495 undergraduates and 2526 graduate or professional students) from a database of all enrolled students who were at least 18 years old. These students were sent emails inviting them to complete the survey on a secure web site. After reading a description of the study, participants indicated their consent by clicking on the link to begin the survey. The study was approved by the university's Health Sciences Institutional Review Board. See Eisenberg et al. (2007) and Eisenberg, Gollust, et al. (2007) for additional details about the study design.

### 2.2. Accounting for non-response bias

We constructed response propensity weights to adjust for differences between respondents and non-respondents, using administrative data on demographic characteristics of the whole sample (gender, race/ethnicity, year in school, international student status, and GPA) and data on depressive symptoms and mental health care utilization from a brief survey of non-respondents to the main survey. A total of  $n = 500$  non-responders were randomly selected for the non-response survey, and  $n = 274$  completed it for a 54.8% response rate. This non-response sample had a lower prevalence of depressive symptoms and mental health service use than the main sample, indicating that depression and service use were positively correlated with propensity to respond to the main survey (presumably because people with symptoms or service use had greater familiarity and interest in a mental health survey; cf. Groves et al., 2006). To the extent that the non-response sample is more representative of non-responders overall than the main sample, incorporating the non-response survey data into response propensity weights will make our estimates more accurate. We followed the approach used by Kessler et al. (2004) in the National Comorbidity Survey Replication (NCS-R) to develop a non-response adjustment weight. Other epidemiologic surveys of mental health and substance use have also used non-response weights to adjust for non-response bias (e.g., the National Epidemiologic Survey on Alcohol and Related Conditions [NESARC]; Grant et al., 2004; and the National Survey on Drug Use and Health [NSDUH]; SAMHSA, 2007). Further details about the construction of the response propensity weights are available in Eisenberg et al. (2007).

### 2.3. Measures

#### 2.3.1. Substance use behaviors

We asked about the frequency of the following substance use behaviors: cigarette smoking (past 30 days), binge drinking (past two weeks), and marijuana use (past 30 days). The questions about smoking ("On average, how many cigarettes did you smoke in the past 30 days?") and binge drinking ("Over the past two weeks, on how many occasions did you have [5 if male, 4 if female] drinks in a row?") were taken from the College Student Life Survey (Boyd & McCabe, 2007) and the College Alcohol Study (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994), respectively. The question about marijuana use ("Within the last 30 days, how many times did you use marijuana (pot, hash, hash oil)?") was taken from the American College Health Association's

National College Health Assessment (ACHA, 2007). Because all three substance use variables were positively skewed, we created binary versions of each variable. With one exception noted below (see Section 3.1.), results did not differ from analyses conducted using variables in their original metrics. In addition, we created a binary variable for “frequent binge drinking,” defined as at least 3 binge drinking occasions in the past two weeks (McCabe, 2002; Presley & Pimentel, 2006; Wechsler et al., 2002).

### 2.3.2. Mental health problems

Symptoms of depression in the past two weeks were measured using the Patient Health Questionnaire-9 (PHQ-9), a screening instrument based on the nine DSM-IV criteria for a major depressive episode (Spitzer, Kroenke, & Williams, 1999). Sample items include “Over the past 2 weeks, how often have you been bothered by feeling down, depressed, or hopeless?” “Over the past 2 weeks, how often have you been bothered by little interest or pleasure in doing things?” Response options are *not at all*, *several days*, *more than half the days*, and *nearly every day*. We used the PHQ-9’s standard algorithm to categorize people as screening positive for major depression, other depression (which includes dysthymia or depression not otherwise specified), any depression (either major or other), or neither. Symptoms of panic disorder and generalized anxiety disorder over the past four weeks were measured using items from the PHQ anxiety module. We used the standard algorithm to categorize people as screening positive for panic disorder, generalized anxiety disorder, either, or neither. The PHQ measures of mental health symptoms have been validated in a variety of populations (e.g., Diez-Quevedo, Rangil, Sanchez-Planell, Kroenke, & Spitzer, 2001; Henkel, Mergl, Kohnen, Allgaier, Moller, & Hegerl, 2004; Kroenke, Spitzer, & Williams, 2001; Lowe, Grafe, Zipfel, Witte, Loerch, & Herzog, 2004). For example, Spitzer et al. assessed the sensitivity and specificity of the PHQ in a sample of 585 family medicine and general internal medicine patients. Within 48 hours of completing the PHQ, patients were interviewed and diagnosed by a mental health professional (a clinical psychologist or psychiatric social worker). Evaluated against the clinical diagnoses, the PHQ had a sensitivity of .73 and specificity of .98 for major depressive disorder; a sensitivity of .63 and specificity of .97 for generalized anxiety disorder; and a sensitivity of .81 and specificity of .99 for panic disorder.

### 2.3.3. Socio-demographic characteristics

We collected information on the following socio-demographic characteristics: gender, academic level (graduate or undergraduate status), age, race/ethnicity, nationality (U.S. or international), living arrangement, sexual orientation, current financial situation, financial situation when growing up, current relationship status, and self, family, or friends’ exposure to hurricane Katrina. Our substantive focus was on gender and academic level, and the remaining variables were treated as covariates in multivariate analyses.

### 2.3.4. Perceived need and utilization of mental health care

We asked all participants about their perceived need for and utilization of mental health services over the past year, using items from the national Healthcare for Communities study (Wells, Sturm, & Burnam, 2004). We coded participants as having a perceived need for help if they responded affirmatively to the question: “In the past 12 months, did you think you needed help for emotional or mental health problems such as feeling sad, blue, anxious or nervous?” Service utilization was indicated if participants reported receiving counseling or therapy for their mental or emotional health from a health professional (psychiatrist, psychologist, social worker, or physician), or if they had taken any psychotropic medications, in the past year. Finally, those who indicated they had received no mental health services were asked if they had visited any medical provider for any reason in the past year.

## 2.4. Statistical analysis

We first estimated the prevalence of substance use behaviors by gender and academic level. Next, to examine associations between mental health problems and substance use behaviors, and other potential correlates, we estimated bivariate logistic regression models with binary indicators of the substance use behaviors as the dependent variables. In order to test the hypothesis that the associations between mental health problems and substance use behaviors are moderated by gender and undergraduate/graduate student status, we conducted a series of hierarchical logistic regression analyses using procedures outlined by Jaccard (2001). For these analyses, we calculated product terms for all possible 2- and 3-way interactions between gender, academic status, and mental health problems. Finally, we estimated the prevalence of mental health service utilization for students who had co-occurrence of frequent (three or more times in the past two weeks) binge drinking and mental health problems, a co-occurrence associated with risk of suicide and other adverse outcomes (Presley & Pimentel, 2006; Tubman, Wagner, & Langer, 2003). Pairwise comparisons between proportions for each type of service use were conducted using procedures outlined by Jaccard and Becker (1997). All analyses incorporated the non-response adjustment weights described above and were performed using Stata 9.0. When statistics were estimated for the pooled sample of undergraduates and graduate students, a post-stratification weight was used to reflect the mix of undergraduates and graduate students (approximately 2:1) of the student population.

## 3. Results

A total of 2,843 students (56.6%) completed the main survey. The sample was comprised of 61.1% undergraduate and 33.9% graduate students. Among undergraduate students, 50.1% were female, and the race/ethnicity breakdown was 68.4% White, 15.5% Asian, 7.0% African American, 3.4% Hispanic, and 5.7% Other. Most undergraduate students (94.1%) were in the “18–22 years” age category. Among graduate students, 44.4% were female, and the race/ethnicity breakdown was 55.1% White, 27.9% Asian, 6.1%

African American, 4.2% Hispanic, and 6.7% Other. Most graduate students (91.6%) were in the “23 years and older” age category. Completed response rates were higher among graduate students (65.8%) than undergraduates (47.3%), among females (61.2%) than males (50.8%), and lower among African American students (46.4%) than White, Hispanic, and Asian students.

### 3.1. Prevalence of substance use behaviors by gender and student status

Table 1 illustrates the frequency of substance use behaviors by academic level and gender. With respect to prevalence of past 30-days smoking, there was no significant difference between undergraduates (15.0%) and graduates (13.5%),  $\chi^2(1)=2.0$ , *ns*. However, undergraduates (51.1%) had significantly higher rates of binge drinking than graduate students (34.7%),  $\chi^2(1)=119.9$ ,  $p<.01$ . Further, undergraduates (16.6%) had significantly higher rates of marijuana use than graduate students (5.8%),  $\chi^2(1)=114.3$ ,  $p<.01$ . Within academic levels, undergraduate males had higher prevalence rates of smoking, binge drinking, and marijuana use than undergraduate females. Graduate males also showed higher rates of smoking than graduate females, but there were no gender differences among graduate students in prevalence of binge drinking or marijuana use. However, when we analyzed the binge drinking variable in its original metric, the frequency of binge drinking in the past 2 weeks was significantly higher among graduate males ( $M=1.72$ ) compared to graduate females ( $M=1.61$ ),  $t(1672)=2.1$ ,  $p<.05$ . Yet, the magnitude of the difference between graduate males' and females' binge drinking, as indexed by Cohen's *d*, was only .11, which corresponds to a small effect (Cohen, 1992). The largest male–female difference was for binge drinking among undergraduate students. Correlations among the substance use measures in their original metrics were all statistically significant but relatively weak in magnitude ( $r<.32$ ). The highest correlation was found between frequency of binge drinking and frequency of marijuana use ( $r=.31$ ).

### 3.2. Main and interactive effects of mental health problems, gender, and academic level on substance use behaviors

A series of bivariate logistic regression analyses was conducted for each of the four substance use variables. As seen in Table 2, major depression, panic disorder, and generalized anxiety disorder were associated with higher odds of cigarette smoking. Other depression and generalized anxiety disorder were associated with higher odds of binge drinking, but only generalized anxiety disorder was associated with higher odds of frequent binge drinking. None of the mental health variables were associated with marijuana use.

Next, procedures outlined by Jaccard (2001) were used to test the main and interactive effects of gender, student status, and mental health problems on the odds of substance use behaviors. We conducted four separate hierarchical multiple logistic

**Table 1**  
Frequency of substance use behaviors by academic level and gender ( $N=2843$ )

	Undergraduates			$\chi^2$	Graduates			$\chi^2$
	Female	Male	All		Female	Male	All	
	<i>n</i> =677	<i>n</i> =504	<i>n</i> =1181		<i>n</i> =819	<i>n</i> =843	<i>n</i> =1662	
Cigarette smoking in past 30 days				119.9**				5.4*
None	87.1	82.9	85.0		88.6	84.8	86.5	
<1 cigarette per day	8.5	10.1	9.3		6.9	7.5	7.2	
1–5 cigarettes per day	3.6	3.4	3.5		2.4	4.3	3.5	
About 1/2 pack per day	0.4	2.2	1.3		1.4	1.8	1.6	
About 1 pack per day	0.5	0.9	0.7		0.8	1.5	1.2	
About 1.5 packs per day	0.0	0.4	0.2		0.0	0.1	0.1	
2 or more packs per day	0.0	0.2	0.1		0.0	0.0	0.0	
Any	12.9	17.1	15.0		11.4	15.2	13.5	
Binge drinking in past 2 weeks				9.1*				2.1
None	51.5	46.2	48.9		67.2	63.8	65.3	
Once	12.1	14.1	13.1		14.7	14.6	14.6	
Twice	16.4	14.3	15.4		9.9	9.8	9.8	
3–5 times	17.1	18.0	17.6		6.8	9.8	8.5	
6–9 times	2.3	5.8	4.1		1.2	1.7	1.5	
10+ times	0.5	1.6	1.1		0.3	0.4	0.4	
Any	48.5	53.8	51.1		32.8	36.2	34.7	
Marijuana use in past 30 days				7.5**				1.2
None	85.2	81.6	83.4		93.6	94.8	94.3	
1–2 days	7.7	8.8	8.2		4.5	3.0	3.7	
3–5 days	3.6	2.4	3.0		0.9	0.9	0.9	
6–9 days	1.4	2.5	1.9		0.5	0.8	0.7	
10–19 days	1.4	2.1	1.7		0.1	0.4	0.3	
20–29 days	0.6	2.2	1.4		0.3	0.0	0.2	
All 30 days	0.2	0.4	0.3		0.0	0.1	0.1	
Any	14.8	18.4	16.6		6.4	5.2	5.8	

Note. Percentages were calculated using response propensity survey weights. Chi-square values refer to tests for gender differences in overall prevalence of each substance use behavior for undergraduate and graduate students separately. For all chi-square tests,  $df=1$ .

\* $p<.05$ . \*\* $p<.01$ .

**Table 2**

Bivariate associations between mental health problems, gender, academic status, and substance use behaviors (N=2843)

Total sample	Any cigarette smoking		Any binge drinking		Any frequent binge drinking		Any marijuana use	
	%	OR (95% CI)	%	OR (95% CI)	%	OR (95% CI)	%	OR (95% CI)
	14.5	–	45.5		18.4		12.9	
<i>Mental health problems</i>								
Major depression	26.1	2.2** (1.6–2.9)	46.9	1.1 (0.8–1.4)	15.8	0.8 (0.6–1.2)	15.0	1.2 (0.8–1.8)
Other depression	14.6	1.0 (0.8–1.4)	50.6	1.2* (1.1–1.5)	20.1	1.1 (0.9–1.4)	14.8	1.2 (0.9–1.6)
Panic disorder	31.6	2.8** (1.7–4.6)	54.1	1.4 (0.9–2.3)	24.3	1.5 (0.9–2.5)	16.9	1.3 (0.7–2.5)
Generalized anxiety Disorder	31.3	2.8** (1.9–4.0)	53.8	1.4* (1.1–1.9)	28.3	1.8** (1.2–2.6)	16.6	1.3 (0.9–2.1)
<i>Gender</i>								
Male	16.4	1.4** (1.2–1.6)	47.3	1.2** (1.1–1.3)	20.4	1.3** (1.1–1.5)	13.6	1.1 (0.9–1.3)
Female <sup>a</sup>	12.4	–	43.6	–	16.3	–	12.1	–
<i>Academic status</i>								
Undergraduate	15.0	1.1 (0.9–1.3)	51.1	2.0** (1.7–2.2)	22.7	2.6** (2.1–3.1)	16.6	3.2** (2.6–4.1)
Graduate <sup>a</sup>	13.5	–	34.7	–	10.3	–	5.8	–

Note. OR = odds ratio. CI = confidence interval. The table shows unadjusted odds ratios from separate bivariate logistic regression analyses predicting each substance use behavior. For mental health problems, parameter estimates are the odds of engaging in each substance use behavior among those with compared to those without that particular mental health problem. Response propensity weights were used.

\* $p < .05$ . \*\* $p < .01$ .

<sup>a</sup> Reference group.

regression analyses that examined mental health problems as predictors of each substance use behavior, controlling for demographic and other relevant variables. For these analyses, all main effects (gender, academic level, mental health problems, and all covariates) were entered at the first step, all product terms for the 2-way interactions were entered at the second step, and all product terms for the 3-way interactions were entered at the third step. Odds ratios are reported separately from each step, i.e., all main effect parameter estimates are from models that do not include product terms (Jaccard, 2001, p. 20). Because none of the 3-way interaction effects were statistically significant, they are not presented or discussed further (Hosmer & Lemeshow, 2000).

Results are presented in Table 3. With respect to main effects, results were similar to those from bivariate analyses and showed that mental health problems were differentially associated with substance use behaviors, even when gender, student status, and other covariates were statistically controlled. Even after statistically controlling for several covariates, major depression, panic disorder, and generalized anxiety disorder were independently associated with greater odds of past-month cigarette smoking. None of the mental health variables was associated with past 2-weeks binge drinking, which suggests that the significant bivariate effects of other depression and generalized anxiety disorder were spurious. By contrast, frequent binge drinking was negatively associated with symptoms of major depression and positively associated with symptoms of generalized anxiety disorder. Consistent with the bivariate results, none of the mental health variables were associated with marijuana use. With respect to gender and academic status, results showed that being male and being an undergraduate were associated with higher odds of all four substance use variables, even after controlling for mental health problems and other covariates. The single exception was that academic status was not associated with cigarette smoking.

We next tested the 2-way interactions between gender, academic status, and mental health problems as predictors of each substance use variable. For smoking and marijuana use, results from hierarchical logistic regression analyses showed that none of the 2-way interaction effects were significant. For any binge drinking, results from a hierarchical logistic regression analyses showed that only one of the product terms was statistically significant. As seen in Table 3, there was a statistically significant 2-way interaction effect between student status and other depression, such that the odds ratio for the association between other depression and binge drinking was almost twice as large among undergraduate students compared to graduate students (AOR=1.77, 95% CI=1.1–3.0,  $p < .05$ ).

Results from the hierarchical logistic regression analyses predicting frequent binge drinking yielded two statistically significant interaction effects, both involving gender. Interestingly, these results diverged from those for any binge drinking. As seen in Table 3, there was a statistically significant 2-way interaction effect between gender and major depression, indicating that the association between major depression and frequent binge drinking was moderated by gender. Recall that the main effect of major depression on frequent binge drinking was negative, i.e., the odds of frequent binge drinking were significantly lower among those with major depression. The 2-way interaction effect indicates that the odds ratio for the association between major depression and binge drinking was significantly lower for males compared to females (AOR=0.25, 95% CI=0.1–0.7,  $p < .01$ ). In addition, Table 2 shows that there was a statistically significant 2-way interaction effect between gender and generalized anxiety disorder, indicating that the association between anxiety and frequent binge drinking was also moderated by gender. Recall that the main effect of GAD on frequent binge drinking was positive, i.e., the odds of frequent binge drinking were significantly higher among those with GAD. The 2-way interaction effect indicates that the odds ratio for the association between GAD and binge drinking was significantly larger for males compared to females (AOR=6.9, 95% CI=2.2–21.4,  $p < .01$ ).

**Table 3**

Main and interactive effects of mental health problems, gender, and academic status on substance use behaviors (N=2843)

Predictor	Any cigarette smoking	Any binge drinking	Any frequent binge drinking	Any marijuana use
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
<i>Mental health problems</i>				
Major depression	1.6* (1.1–2.2)	1.0 (0.7–1.3)	0.7* (0.4–1.0)	1.1 (0.7–1.6)
Other depression	0.9 (0.7–1.3)	1.2 (0.9–1.5)	0.9 (0.7–1.2)	1.0 (0.7–1.4)
Panic disorder	2.0* (1.2–3.4)	1.1 (0.7–1.9)	1.3 (0.7–2.4)	0.9 (0.5–1.8)
Generalized anxiety Disorder	1.9** (1.2–2.9)	1.2 (0.8–1.8)	2.0** (1.3–3.1)	1.2 (0.7–2.0)
<i>Gender</i>				
Male	1.4** (1.2–1.7)	1.2** (1.1–1.4)	1.4** (1.2–1.6)	1.3* (1.1–1.5)
Female <sup>a</sup>	–	–	–	–
<i>Academic status</i>				
Undergraduate	1.2 (0.9–1.5)	1.5** (1.2–1.7)	1.7** (1.3–2.1)	2.5** (1.9–3.2)
Graduate <sup>a</sup>	–	–	–	–
<i>Product terms for 2-way interaction effects</i>				
Male×MD	0.7 (0.3–1.4)	1.7 (0.9–3.2)	0.2** (0.1–0.7)	0.8 (0.3–1.8)
Male×OD	1.1 (0.6–1.2)	1.0 (0.6–1.6)	1.4 (0.7–2.5)	1.0 (0.5–1.8)
Male×PD	1.6 (0.5–5.4)	0.5 (0.2–1.5)	1.8 (0.5–7.0)	1.8 (0.4–7.5)
Male×GAD	1.7 (0.7–4.3)	1.1 (0.4–2.6)	6.9** (2.3–21.4)	0.6 (0.2–1.8)
Undergraduate×MD	0.8 (0.3–1.7)	0.9 (0.5–1.9)	0.6 (0.2–1.9)	0.6 (0.2–1.9)
Undergraduate×OD	1.0 (0.5–1.9)	1.8* (1.1–3.0)	1.9 (0.8–4.5)	0.7 (0.3–1.6)
Undergraduate×PD	2.8 (0.7–11.9)	0.3 (0.1–1.1)	0.4 (0.1–1.7)	1.2 (0.2–8.0)
Undergraduate×GAD	2.4 (0.9–6.4)	1.1 (0.5–2.7)	1.8 (0.6–6.0)	4.6 (0.9–24.0)
Male×Undergraduate	1.0 (0.7–1.4)	0.8 (0.6–1.1)	0.7 (0.5–1.0)	0.3 (0.8–2.1)

Note. AOR = adjusted odds ratio. CI = confidence interval. The table shows adjusted odds ratios from five separate hierarchical multiple logistic regression analyses. All analyses statistically controlled for race/ethnicity, international student status, living arrangement, sexual orientation, current financial situation, family's financial situation growing up, relationship status, and self, family, or friends' exposure to hurricane Katrina. MD=Major depression, OD=Other depression, PD=Panic disorder, GAD=Generalized anxiety disorder. Response propensity weights were used.

\* $p < 0.05$ . \*\* $p < 0.01$ .

<sup>a</sup> Reference group.

None of the 2-way gender× academic level interaction effects were statistically significant. Results indicate that the effects of gender and academic level on substance use are additive.

### 3.3. Service use by students with co-occurring frequent binge drinking and mental health problems

Finally, we examined the perceived need for help and actual mental health service use for a set of students with particularly elevated risk, those with co-occurring frequent binge drinking and mental health problems. We focused on binge drinking because it is more prevalent among college students than smoking and marijuana use (Johnston et al., 2007), and we further restricted this group to frequent binge drinkers based on evidence that this level of heavy, frequent alcohol use is associated with numerous negative consequences, including suicidal ideation and suicide attempts (Presley & Pimentel, 2006). As seen in Table 4, relative to

**Table 4**

Service use by students with co-occurring mental health problems and frequent binge drinking

Service use	Frequent binge drinking (3+ times in past 2 weeks) co-occurring with:						
	None of these mental health problems (n=751)	Any of these mental health problems (n=151)	Major depression (n=38)	Other depression (n=80)	Suicidal thoughts (n=30)	Panic disorder (n=18)	GAD (n=41)
Perceived a need for help <sup>a</sup>	23.7	66.9*	76.3*	58.2*	80.0*	77.8*	81.0*
Psychotropic medication	9.5	26.9*	38.9*	17.3	37.9*	82.4*	48.7*
Therapy/counseling	7.6	25.3*	42.1*	15.0	33.3*	57.9*	47.6*
Medication or therapy/counseling	13.9	37.9*	58.3*	25.3*	40.0*	82.4*	66.7*
Any visit to health professional	79.0	82.7	84.6	78.8	70.0	94.4	88.1

Note. Response propensity weights were used. Within each row, asterisks indicate a statistically significant difference between the proportion of participants with a mental health problem and those reporting "none of these mental health problems" in use of services. Pairwise comparisons between proportions for each type of service use were conducted using procedures outlined by Jaccard and Becker (1997), and Holm's modified Bonferroni procedure (Holland & Copenhaver, 1988; Holm, 1979) was used to maintain the Type I error rate at .01 within each row.

\* $p < .01$ .

<sup>a</sup> "Perceived a need for help" was based on the question, "In the past 12 months, did you think you needed help for emotional or mental health problems such as feeling sad, blue, anxious or nervous?"

those students who reported frequent binge drinking with no mental health problems, those who reported co-occurring frequent binge drinking and each mental health problem had higher rates of perceiving a need for help, use of psychotropic medication, use of therapy/counseling, and use of medication or therapy/counseling. There were only two exceptions to this pattern: participants with co-occurring frequent binge drinking and “other depression” did not differ from those with frequent binge drinking alone in terms of psychotropic medication use or therapy/counseling. Of students who reported frequent binge drinking and who also had symptoms consistent with mental health problems, about 67% perceived a need for help in the previous year, but only about 38% actually received psychotropic medication or had at least one visit for therapy or counseling.

#### 4. Discussion

This study addressed three questions: 1) What is the prevalence of substance use behaviors in college students, overall and by gender and academic level (undergraduate vs. graduate)? 2) How are substance use behaviors associated with mental health problems and, do these patterns of co-occurrence vary by gender and academic level? 3) What proportion of students with a particularly risky type of co-occurrence – frequent binge drinking and mental health problems – receive mental health services?

With respect to the first question, we found that undergraduate students, relative to graduate students, were significantly more likely to engage in heavy drinking and marijuana use, and about equally likely to smoke cigarettes. Our findings are consistent with previous work showing that smoking rates peak in the early 20s and slowly decline thereafter (Johnston et al., 2007; SAMHSA, 2007). Sharper age-related declines in alcohol and marijuana involvement compared to smoking may be an indication that smoking behavior is more resistant to change (Bachman et al., 2002). Lower levels of binge drinking and marijuana use among graduate students are consistent with previous studies showing that students generally “mature out” of these risky behaviors following college (Bachman et al., 2002; Jackson, Sher, Gotham, & Wood, 2001). Alcohol and marijuana use – more so than cigarette use – are age-graded phenomena that peak in late adolescence/early adulthood and decline as people enter the full-time work force, get married, and become parents (Sher & Gotham, 1999; cf. Bachman, Wadsworth, O'Malley, Johnston, & Schulenberg, 1997). Further, selection and socialization processes may partly explain lower levels of alcohol and marijuana use among graduate students. Recent evidence from the NCS-R (Breslau, Lane, Sampson, & Kessler, 2008) showed that alcohol and drug abuse were independently associated with lower odds of 1) finishing high school; 2) entering college (among those who completed high school); and 3) completing college (among those who entered college). It follows that those with higher levels of substance use as undergraduates may be less likely to pursue graduate education (cf. Wood, Sher, & McGowan, 2000; also see Gotham, Sher, & Wood, 2003). Also, with respect to socialization processes, two factors that are consistently associated with undergraduate substance use (fraternity/sorority membership and exposure to heavy-drinking peers; see Capone, Wood, Borsari, & Laird, 2007; McCabe et al., 2005) are less likely influence substance use behaviors of graduate students.

Gender differences were also observed, and male students engaged in all substance use behaviors more frequently than females, with the exception of marijuana use among graduate students. Findings are consistent with a long line of evidence for higher substance use levels among college males compared to females (for reviews, see Ham & Hope, 2003; Jackson, Sher, & Park, 2005). These gender differences were only slightly attenuated among graduate students, and there was no evidence that gender differences varied significantly by academic status. These academic level and gender differences in the likelihood of substance use behaviors remained even after statistically controlling for several relevant demographic variables and risk factors, which indicates that subgroup differences in substance use were not spurious.

With respect to our second question, mental health problems were differentially associated with substance use behaviors, and some of these associations varied by gender or academic level. Major depression, panic disorder, and generalized anxiety disorder were independently associated with higher odds of smoking, both in bivariate and multivariate analyses. Odds ratios for these associations were similar (albeit smaller in magnitude) to those reported by Grant et al. (2004, 2005) for associations between mood and anxiety disorders and nicotine dependence in the NESARC. Results are consistent with negative reinforcement models of cigarette smoking (Baker, Brandon, & Chassin, 2004; Kassel, Stroud, & Paronis, 2003), which assume that substance use is motivated, in part, by the desire to reduce negative affect. However, the finding that depression, panic disorder, and GAD were all uniquely associated with smoking is a novel finding. Few studies have simultaneously examined depression and anxiety as predictors of smoking. Some evidence indicated that depressive but not anxiety symptoms were predictive of smoking in a sample of internal medicine outpatients (Kick & Cooley, 1997). By contrast, Breslau (1995) found that depression and anxiety were independently associated with nicotine dependence, but not with smoking status in a sample of young adults. Finally, in a sample of college students, Psujek, Martz, Curtin, Michael, and Aeschleman (2004) found that neither depressive nor anxiety symptoms predicted nicotine dependence. Our results are most similar to those of Breslau (1995) and highlight the possibility that smoking may have stronger linkages to categorical versus dimensional measures of psychopathology.

Previous research indicated that the association between symptoms of depression and smoking was stronger for females than males (Acierno et al., 2000; Poulin, Hand, Boudreau, & Santor, 2005). However, other research has reported conflicting findings (Breslau, Peterson, Schultz, Chilcoat, & Andreski, 1998; Vickers et al., 2003), and it appears that the co-occurrence of major depression and smoking varies as a function of how smoking is operationalized (Johnson, Rhee, Chase, & Breslau, 2004). Recent reviews of the literature on smoking and anxiety disorders (Morissette et al., 2007; Zvolensky & Bernstein, 2005) noted that the prevalence of smoking is highest among those with panic disorder and those with PTSD. Our findings support the strong association between smoking and symptoms of panic disorder and suggest that this relationship cannot be explained by depression or GAD.



Our findings on frequent binge drinking were particularly interesting. Major depression was associated with lower odds of frequent binge drinking, whereas GAD was associated with higher odds of frequent binge drinking. Both associations were significantly stronger for males than females. The inverse association between depression and binge drinking seems counterintuitive in light of consistent epidemiologic evidence for co-occurrence of depression and alcohol use disorders (Grant et al., 2004; Office of Applied Studies, 2007). However, results from the NESARC (Dawson et al., 2005) indicated a direct association between major depression and binge drinking among non-college students but not among college students. Dawson et al. suggested that this null association could be a selection effect, whereby those with co-occurring disorders are less likely to attend college. Another possibility is that some college males who engage in frequent binge drinking do so as a relatively routine part of college life, and as such their binge drinking is not tied to affect regulation drinking motives (cf. Chassin, Pitts, & Prost, 2002).

By contrast, GAD was associated with higher odds of frequent binge drinking. This finding is consistent with previous work showing that anxiety and anxiety disorders are associated with AUDs in college (Kushner & Sher, 1993) and non-college samples (Grant, Hasin et al., 2004). However, our results also indicated that the positive association between GAD and frequent binge drinking was stronger for males than females. Similar findings were reported by Geisner, Larimer, and Neighbors (2004), who found stronger associations between psychological distress, alcohol consumption and alcohol-related problems for male compared to female college students (also see Stewart et al., 2001). Morris, Stewart, and Ham (2005) reviewed other studies showing that the association between anxiety and alcohol involvement appears to be stronger for males than females. They suggested that men may be more likely than women to rely on alcohol consumption as a means of reducing anxiety, in part because they have more positive alcohol-related expectancies. Our findings suggest that this effect may be most apparent for frequent binge drinking. Future research will benefit from the observation that the association between anxiety and alcohol involvement varies as a function of how these constructs are operationalized (Kushner, Abrams, & Borchardt, 2000). Thus, it may be that the interaction effect we observed is specific to the association between GAD and frequent binge drinking (cf. Dawson et al., 2005).

None of the bivariate or multivariate associations between mental health problems and marijuana use were significant. Previous research has yielded conflicting findings with respect to the association between marijuana involvement and depression (Degehard et al., 2003). Recent evidence from the NESARC indicated positive associations between mood and anxiety disorders and cannabis use disorders in the general population (Stinson, Ruan, Pickering, & Grant, 2006). Gender differences in associations between marijuana use motivations and frequency of marijuana use have also been reported (Chabrol, Duconge, Casas, Roura, & Carey, 2005), but we found no evidence for gender moderation in our sample. Buckner, Bonn-Miller, et al. (2007) showed that social anxiety was related to marijuana use problems but not frequency of use in college students. Given the low base rate of marijuana use in this sample, it may be that the co-occurrence of mental health problems is limited to small subgroups of students with more problematic use.

With respect to our third and final question, we found that about 67% of students with co-occurring frequent binge drinking and mental health problems perceived a need for help with their mental health problems, yet only 38% reported receiving mental health services in the previous year. Previous studies have shown that, compared to those with a substance use or mental health problem alone, individuals with co-occurring substance use and mental health problems have more severe and chronic disorders (Hanna & Grant, 1997), greater functional impairment (Davis et al., 2005), and higher risk of suicide (Cornelius et al., 1995). Our results highlight the importance of improving access to prevention and intervention programs among college students with co-occurring substance use and mental health problems. The effectiveness of initiatives designed to address substance use behaviors and associated mental health problems among college students may be enhanced if health professionals recognize that there may be substantial unmet needs for treatment (cf. Wu, Pilowsky, Schlenger, & Hasin, 2007).

#### 4.1. Limitations

Our results should be interpreted in the context of several limitations to our study. Data were collected from one university, and it is not known if these findings can be generalized to students from other universities. Also, the use of a “past 2 weeks” time frame for the measure of binge drinking may underestimate the prevalence of heavy drinking (see Dawson et al., 2004). Indeed, previous studies have shown that the use of longer time frames results in higher prevalence estimates of binge drinking (Cranford, McCabe, & Boyd, 2006; Vik, Tate, & Carrello, 2000). We refer the reader to Dawson et al. (2004), Slutske et al. (2004), and especially LaBrie, Pedersen, and Tawalbeh (2007) and Vik et al. (2000) for a discussion of this issue.

Another limitation is that assessment of mental health problems was based on self-reports and screening measures, and although these measures have good psychometric properties, it is not clear if the use of diagnostic interviews would yield similar results. In addition, the cross-sectional design of our study precluded the identification of temporal order of associations between substance use behaviors and mental health problems. For example, we do not know if the observed association between GAD and frequent binge drinking reflects 1) a direct effect of GAD on binge drinking, 2) a direct effect of binge drinking on GAD, 3) a bidirectional causal relationship, or 4) a spurious association due to some unobserved third variable (see Jackson & Sher, 2003). The cross-sectional design also precluded examination of the hypothesis that lower substance use rates among graduate students are due to selection, socialization, or causation effects (e.g., undergraduates who are heavy substance users are less likely to pursue graduate education; cf. McCabe et al., 2007; Wood, Sher, & McGowan, 2000), age effects (i.e., “maturing out” of substance use; Gotham, Sher, & Wood, 1997), or some combination of these processes. Finally, although we statistically controlled for some distal and proximal correlates of substance use, we cannot rule out the possibility that the observed associations between mental health problems and substance use were spurious.

## 4.2. Strengths

Despite these limitations, our study has several methodological strengths. The use of a random sample increases confidence in the generalizability of our findings to this population, and we used response propensity weights to adjust for non-response bias. The relatively large sample size allowed us to test gender and academic level as potential moderators of the associations between mental health problems and substance use behaviors, and we statistically controlled for several demographic variables and risk factors. Also, despite its limitations, our study makes several important substantive contributions. First, our results indicate that associations between mental health problems and substance use in college samples may be specific to cigarette smoking and frequent binge drinking. Second, we found that major depression, panic disorder, and generalized anxiety disorder were independently associated with cigarette smoking. Given the high levels of comorbidity between these mental health problems, it is noteworthy that all of them were independently associated with smoking. Third, we found that major depression was associated with lower levels of frequent binge drinking; by contrast, anxiety was associated with higher levels of frequent binge drinking. Further, these associations were significantly stronger among males than females. To our knowledge, this is the first study to report this pattern of associations. Fourth, results indicated a discrepancy between perceived need for services and use of those services among frequent binge drinkers, and this discrepancy increased substantially among those reporting at least one mental health problem.

## 4.3. Conclusions

Taken together, results from the current study lend strong support to negative reinforcement models of cigarette smoking, highlight the importance of distinguishing the effects of mood and anxiety disorders on substance use, and indicate the need to improve linkage to treatment for students with co-occurring frequent binge drinking and mental health problems. As such, our findings may allow for more focused prevention and intervention efforts that target subgroups of students at greater risk for particular patterns of co-occurrence.

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