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Alcohol consequences, not quantity, predict major depression onset among first-year female college students



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HIGHLIGHTS

- Quantity of alcohol consumed did not predict onset of depression among female college students.
- Alcohol consequences did predict onset of depression among female college students.
- College substance use and mental health interventions should aim to reduce alcohol consequences.

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ABSTRACT

Alcohol use and its consequences have often been associated with depression, particularly among female college students. Interpretation of this association has been challenging due to potential reverse causation. The current study sought to clarify the temporality of these relationships. We examined: (1) the association between alcohol consumption and onset depression among female college students, and (2) the association between drinking consequences and onset depression among drinkers only. We used a prospective longitudinal design. Participants were first-year female college students who completed a baseline survey at study entry, and monthly assessments of alcohol consumption, drinking consequences, and depression symptoms. Cox proportional hazards regression with time-varying covariates were constructed among the full sample ($N = 412$) and the drinkers only sample ($N = 335$). Adjusted hazard ratios accounted for known risk factors for depression such as race/ethnicity, academic challenge, not getting along with one's roommate, sexual victimization prior to college, marijuana use, and socioeconomic status. For each additional average drink per week, adjusting for all covariates, there was no (95% CI: -4%, +4%) increased risk of onset depression. For each additional alcohol consequence, adjusting for all covariates, there was a 19% (95% CI: 5%, 34%) increased risk of onset depression. This significant relationship remained after adjusting for quantity of alcohol consumption. Quantity of alcohol consumed did not predict incident depression. However, experiencing alcohol consequences, regardless of consumption, did increase the risk of incident depression. College substance use and mental health interventions should aim to reduce not only alcohol consumption, but also alcohol-related consequences.

1. Introduction

Alcohol use is often associated with depression (McEachin et al., 2008; Paljarvi et al., 2009; Sihvola et al., 2008). This association is frequently observed on college campuses where alcohol misuse is

common (Hingson, 2010; Johnston et al., 2012) and where many students, especially females (de Graaf et al., 2003; Weitzman, 2004), experience depression for the first time (Eisenberg et al., 2007).

Two major perspectives seek to explain the alcohol–depression relationship. First, mood disorders may cause alcohol misuse through a

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“self-medication” process (Sihvola et al., 2008; Weiss et al., 2004). Second, alcohol misuse may cause depression (Boden & Fergusson, 2011; Paljarvi et al., 2009) through (a) social, economic, and legal consequences that trigger depression (Gibb & Coles, 2005) and/or (b) physiologic changes that increase risk of depression (e.g., ethanol consumption reduces production of methylenetetrahydrofolate reductase, which reduces folate levels, a risk factor for depression) (McEachin et al., 2008). Among these mechanisms, the second highlights that negative alcohol consequences may lead to depression. A previous study among college students suggests there is an association between alcohol-related negative consequences and psychological distress—though this relationship is moderated by gender (Geisner et al., 2004).

Clarifying the causal nature of the alcohol—and alcohol consequences—depression relationship is challenging due to suboptimal research design (Turner & McLellan, 2009) and measurement differences. Most studies have used retrospective or cross-sectional designs that preclude causal inference (Geisner et al., 2004; Hasin & Grant, 2002), and few have examined the relationship between *alcohol consumption* and depression (McEachin et al., 2008; Paljarvi et al., 2009; Sihvola et al., 2008) most investigated the relationship between *alcohol abuse/dependence* and depression (Almeida et al., 2014; de Graaf et al., 2003). Other measurement differences e.g., measuring depression based on symptoms vs. diagnosis (Almeida et al., 2014; Boden & Fergusson, 2011; Hasin & Grant, 2002; Paljarvi et al., 2009; Sihvola et al., 2008) further cloud interpretation.

Two studies have examined the effect of alcohol consumption on depression using a prospective design. One study of adults aged 20–54 found that binge drinking, not average intake, was associated with depressive symptoms five years later (Paljarvi et al., 2009). A study of teenagers followed into their 20s found that heavier alcohol use during emerging adulthood was independently associated with later depression (Sihvola et al., 2008). Both studies suggest that heavy alcohol consumption can lead to depressive symptoms. To our knowledge, no studies have used a prospective design to assess the relationship between negative alcohol consequences and subsequent depressive symptoms.

In the current study, we used a year-long prospective design with high-resolution (i.e., monthly) measurements to examine the effects of alcohol use and consequences on the risk of new onset major depression among first-year college students. Given the moderating role of gender in these potential causal mechanisms (Geisner et al., 2004) and the variation in frequency and type of alcohol consequences experienced by gender (Hammer & Pape, 1997; Perkins, 2002), this study was restricted to only female college students. We hypothesized that, given the particularly vulnerable period of the transition to adulthood marked by increased depression risk and widespread risky alcohol use, both alcohol consumption and consequences would be independent risk factors for incident depression among first-year female college students.

2. Materials and methods

2.1. Participants

Participants were first-year female undergraduates attending a private university in upstate New York. Students were excluded if they were 18 or > 25 years of age or scholarship athletes (due to NCAA restrictions). Recruitment began one month before the Fall 2009 semester with a mailing to incoming female students. We also used flyers, word of mouth, and a departmental research pool. The university's Institutional Review Board approved all procedures.

In total, 483 of 1400 (26%) of incoming female students enrolled. The sample's racial/ethnic distribution was equivalent to the full female class. To address our aims, we used two analytic samples (see Fig. 1 for criteria): one that included 412 females, both drinkers and non-drinkers, to examine the effect of alcohol consumption on the onset of

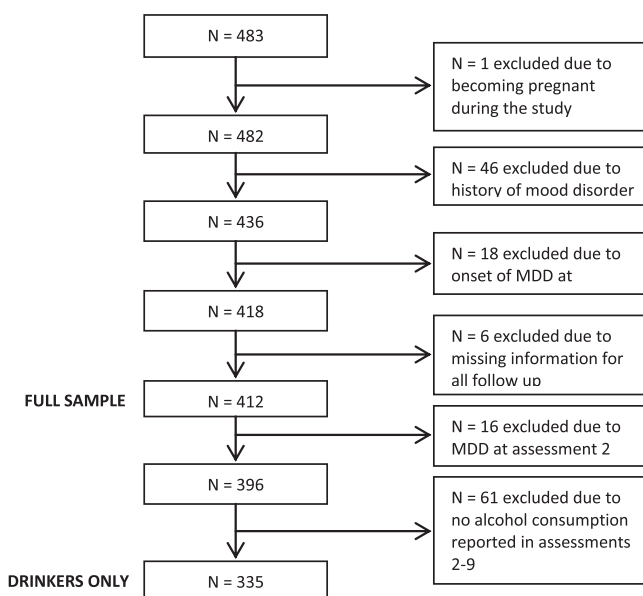


Fig. 1. Flowchart summarizing the constructions of the two analytic samples: the full sample and a sample of drinkers only.

depression, and one that included 335 females who reported drinking any alcohol during the year, to examine the effect of drinking consequences on the onset of depression. Females were excluded if they (a) became pregnant (0.2%) because pregnancy has been linked to depression (Beck, 2001); (b) reported a history of any mood disorder or met criteria for depression at baseline (13%) because we sought to examine predictors of incident depression; (c) did not complete all follow-ups (1%). The second analytic sample included only drinkers and those for whom exposure was assessed prior to the onset of depression ($n = 335$). Because drinking consequences were only assessed starting with assessment two, those with the onset of depression reported at assessment two were excluded (4%). Analyses were restricted to those who reported drinking alcohol between assessments 2 and 9.

2.2. Design and data collection

Data for this study come from a larger study (Fielder et al., 2014) that used a longitudinal design with a baseline and 12 monthly surveys. We used data from August 2009 through May 2010 to limit expected increased within- and between-person variation in alcohol consumption in summer months. During their first three weeks on campus, interested students attended an orientation session where the study was explained. After providing written informed consent, participants completed the baseline survey in-person on individual computers, and follow-up surveys remotely online. Participants received \$20 for the baseline and \$10 for each follow-up survey.

2.3. Measures

The primary outcome was time to onset of major depressive disorder (MDD) using the Patient Health Questionnaire-9 (PHQ-9; (Spitzer et al., 1999)), a 9-item scale commonly used to assess depression based on diagnostic criteria (DSM-IV; (American Psychiatric Association, 1994)). The PHQ-9 was administered at each monthly assessment. Major depression is diagnosed if ≥ 5 of 9 criteria have been present at least “more than half the days” in the past two weeks, and one of the symptoms is depressed mood or anhedonia. The PHQ-9 is a reliable and valid measure of MDD (Kroenke et al., 2001), including in college-aged samples (Kahler et al., 2004). Internal consistency (Cronbach's α) for this sample ranged from 0.80 to 0.87.

We examined average drinks per week in the last month (a continuous variable) using the Daily Drinking Questionnaire (DDQ; (Collins et al., 1985)). At each assessment, referring to standard drinks, students were asked: “Think of a typical week in the last month. Enter the average number of drinks you consumed on each day of a typical week. That is, type in the number of drinks you had on an average Sunday, an average Monday, etc. If you usually did not drink on a given day of the week, put zero (0).” We computed the average drinks per week in the last month. For secondary analyses, participants also reported frequency of heavy episodic drinking (using the female definition of drinking four or more standard alcoholic drinks on one occasion) measured as a continuous variable.

We also assessed alcohol consequences in the last month. This continuous measure was calculated as the summary count of drinking consequences at each monthly assessment. The 12 yes-no questions were derived from previously validated drinking consequences measures: the Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; (Kahler et al., 2005)), the Core Alcohol and Drug Survey (Presley et al., 1994), and the National College Health Assessment (American College Health Association, 2009). Non-overlapping items were selected based on item clarity and frequent endorsement in prior research. Each of the 12 consequence indicators can be seen in Table 1. All yes responses were summed. The alcohol consequences items had good internal consistency with an average Cronbach's alpha of 0.76 (range: 0.69 to 0.81).

Other variables that have been previously identified as risk factors for depression were included as potential confounders: race/ethnicity, socioeconomic status (SES), social connectedness (Lenz, 2004), academic challenge (Kadison & DiGeronimo, 2004), relationship with one's roommate (Joiner Jr. & Metalsky, 1995), history of sexual victimization (Zinzow et al., 2012), and marijuana use (Durdle et al., 2008).

Race/ethnicity was categorized as a dichotomous variable (i.e., white, non-Hispanic versus all else) and included as a time-fixed variable in all analyses.

Because subjective rating of SES is more predictive than objective measures (Cohen & Garcia, 2008; Cohen et al., 1997), perceived family SES was determined by responses to the question, “Please select the rung where you think your family stands at this time in your life, relative to other families in the United States.” The response ranged from “1” (lowest rung of the ladder) to “10” (highest rung) (Adler et al., 1994; Adler et al., 2000). Family SES was categorized into three groups: Low rungs 1 through 5, Middle (rungs 6 and 7), or High (rungs 8 through 10) and included as a time-fixed variable in all analyses.

Social connectedness was measured by the Social Connectedness Scale–Revised (Lee et al., 2001), a 20-item scale with both positively and negatively worded items. Response options ranged from strongly

disagree to strongly agree. Higher scores indicate more social connectedness. Social connectedness was measured during September ($\alpha = 0.86$) and January ($\alpha = 0.87$).

Both academic challenge and relationship with one's roommate were measured with single items. Students rated “The academic expectations at [university] are challenging for me” and “I get along well with my roommate(s)” on Likert scales. Two scores were obtained by combining: (a) those who “strongly disagree”, “disagree”, “mildly disagree” or “mildly agree,” and (b) those who “agree” or “strongly agree.” These questions were asked at the beginning of the first semester (September), end of the first semester (December), and middle of the second semester (March).

Sexual victimization was measured at baseline using a variation of the Revised Sexual Experiences Survey (Testa et al., 2010), which avoids the use of terms that are poorly understood and differentially defined by respondents. The 20-item measure crossed four perpetrator tactics with five types of sexual contact. All participants reporting any prior experience of sexual intercourse due to: verbal coercion, threats of harm, physical force, or incapacitation were categorized as having experienced sexual victimization prior to college.

Marijuana use was dichotomized into those reporting zero days (no use) and those reporting ≥ 1 day in the past month, collected at every assessment.

2.4. Statistical analysis

First, we compared the sociodemographic characteristics of those with and without onset of MDD using the chi-squared test for categorical variables and *t*-tests for continuous variables. We also used the Kaplan-Meier method and log-rank test to determine whether time to onset of MDD varied by the primary exposures measured at baseline. For these analyses, both variables were categorized into quartiles. Next, we used bivariable Cox proportional hazards regression with time-varying covariates to determine the association between drinks per week and time to onset of MDD (full sample), and the association between drinking consequences and time to onset of MDD (drinkers only). In secondary analyses, we used Cox regression to examine the association between heavy episodic drinking and time to onset of MDD. Participants with onset of MDD were right-censored at the assessment during which the onset of depression was reported. Persons who never had onset of depression were right-censored at their last assessment.

To account for potential confounders, two separate multivariable Cox proportional hazards models with time-varying covariates were constructed to calculate the adjusted hazard ratios for each independent variable of interest. To avoid associations attributable to reverse causation, we lagged the independent variables such that the covariate values obtained at the follow-up prior to that in which onset of depression was recorded (*t*-1) were used to predict the likelihood of the outcome at *t*. Sensitivity analyses were conducted among the full sample to assess whether our results were affected by (a) allowing for a quadratic relationship between average drinks per week and onset of MDD, (b) introducing a 2-month lag between the primary exposure and the onset of MDD (to account for any less severe prodromal symptoms of depression), and (c) the cumulative effects of average drinks per week or heavy episodic drinking on the onset of MDD as well as among the drinkers only sample to assess whether our results were affected by allowing for a quadratic relationship between alcohol consequences and onset of MDD. The proportional hazard assumption was assessed by examining time-by-covariate interactions (Hess, 1994). Analyses were conducted using SAS 9.1.3; *p*-values were two-sided.

3. Results

Both the full sample and drinkers only were predominantly white and non-Hispanic (65% and 69%, respectively). In the full sample 12% were Asian, 9% were Black, 9% were Hispanic, and 5% were other race.

Table 1

Alcohol consequences assessed over past month.

1. I had a hangover the morning after
2. I felt sick to my stomach or threw up after drinking
3. I could not remember stretches of time while drinking
4. I missed a class due to drinking
5. The quality of my work or school work has suffered because of my drinking
6. I got hurt or injured when drinking
7. I got into an argument or fight after drinking
8. I did something I later regretted because I was drinking
9. My drinking created problems with a friend
10. I felt badly about myself because of my drinking
11. I got into sexual situations I later regretted because of drinking
12. I need larger amounts of alcohol to feel an effect, or I can no longer get drunk on the amount that used to get me drunk

NOTE: These twelve questions were based on previously validated drinking consequences measures, the Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; (Kahler et al., 2005)), the Core Alcohol and Drug Survey (Presley et al., 1994), and the National College Health Assessment (American College Health Association, 2009).

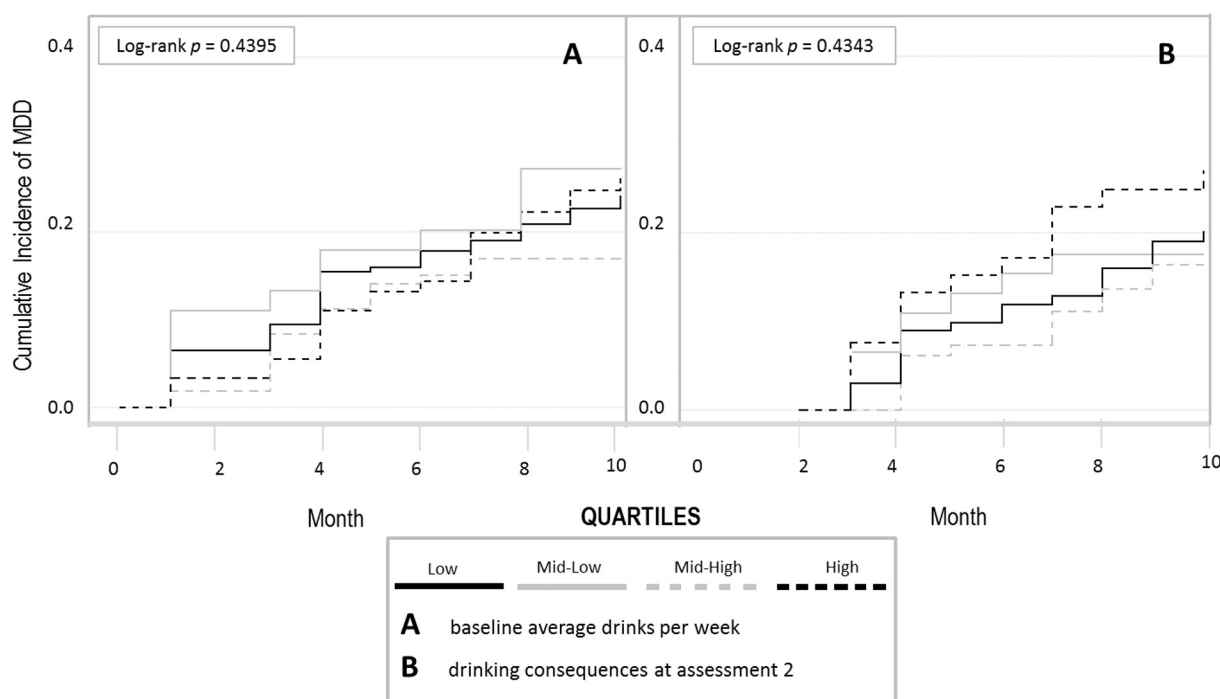


Fig. 2. Cumulative incidence of major depressive disorder among first-year female college students, stratified by average drinks per week (Panel A) and drinking consequences (Panel B) reported at baseline and assessment two, respectively. Panel A full sample ($n = 412$); Panel B drinkers only ($n = 335$).

All participants were between the ages of 18 and 20 years, with 95% being 18 years old. The majority perceived themselves to be middle or high SES (67% full sample, 69% drinkers only). In the full sample, 80% reported heavy episodic drinking at least once during follow-up. In the drinkers only sample, > 90% of participants reported heavy episodic drinking. Among drinkers, the mean number of drinking consequences reported ranged from 1.52 (SD = 0.13) to 2.10 (SD = 0.15) per month. Log-rank tests indicate that quartiles of baseline average drinks per week were not associated with incident MDD among the full sample (See Fig. 2: A), nor were quartiles of alcohol consequences at the second assessment associated with incident MDD among drinkers (See Fig. 2: B).

Among the full sample, 93 (23%) females experienced incident MDD during the year (incidence rate = 36.0 per 100 person-years). Among drinkers, 63 (19%) females experienced new onset MDD during the year (incidence rate = 32.8 per 100 person-years). As shown in Table 2, in both samples, a greater proportion of females reported having experienced sexual victimization prior to college among those that developed MDD than among those who did not ($p \leq .01$). Similarly, a greater proportion of females who reported not getting along with their roommate developed MDD than those who did not ($p \leq .05$). Females that developed MDD had lower baseline social connectedness scores ($p < .01$).

As shown in Table 2, onset MDD was unrelated to average drinks per week at baseline ($p = .48$). Among drinkers only, baseline reported number of alcohol consequences was also unrelated to the subsequent development of MDD over the study period ($p = .14$).

In the unadjusted Cox proportional hazards models (Table 3), average drinks per week was not associated with the onset of MDD (hazard ratio [HR] = 0.99; 95% CI: 0.96–1.02). In contrast, a one-unit increase in the number of reported alcohol consequences was positively associated with a 15% increase in the risk of new onset MDD among drinkers only (HR = 1.15; 95% CI: 1.02–1.29). Other factors that were associated with the onset of MDD were sexual victimization prior to college (full sample HR = 1.90; 95% CI: 1.15–3.14, drinkers only HR = 2.23; 95% CI: 1.24–3.98) and not getting along with one's roommate (full sample HR = 2.03; 95% CI: 1.22–3.38, drinkers only

Table 2
Sociodemographic baseline characteristics of those with and without the onset of MDD in the full sample and among drinkers only.

Baseline characteristics	Full sample N = 412		Drinkers only N = 335	
	No N = 319 (77.4)	Yes N = 93 (22.6)	No N = 272 (81.2)	Yes N = 63 (18.8)
Average drinks per week [mean (SD)]	4.81 (0.36)	5.38 (0.80)		
Alcohol consequences at 2nd assessment [mean (SD)]			1.72 (0.12)	2.16 (0.33)
Don't get along with roommate	27 (8.6)	18 (20.0)	22 (8.2)	10 (16.7)
Social connectedness [mean (SD)]	4.80 (0.05)	4.07 (0.11)	4.86 (0.05)	4.16 (0.13)
Use marijuana	83 (26.0)	26 (28.0)	83 (30.5)	20 (31.8)
Challenging academic expectations	124 (39.7)	41 (46.1)	101 (38.0)	27 (45.0)
Sexual victimization prior to college	33 (10.4)	19 (20.4)	30 (11.1)	16 (25.4)
Socioeconomic status				
Low	92 (28.8)	30 (32.3)	72 (26.5)	21 (33.3)
Middle	135 (42.3)	39 (41.9)	120 (44.1)	26 (41.3)
High	59 (18.5)	17 (18.3)	52 (19.1)	13 (20.6)
White, non-Hispanic	210 (65.8)	58 (62.4)	189 (69.5)	42 (66.7)

Abbreviations: MDD, major depressive disorder
The χ^2 test was used to compare distributions of categorical variables and t-tests were used for continuous variables.

Bold font indicates significant results at $\alpha = 0.05$.

^a Unless otherwise indicated.

HR = 2.07; 95% CI: 1.11–3.86). The only factor negatively associated with the onset of MDD was social connectedness (full sample HR = 0.50; 95% CI: 0.42–0.61, drinkers only HR = 0.48; 95% CI:

Table 3
Cox Proportional Hazards Models Determining Factors Associated with New Onset MDD among Female First-Year College Students.

Time-varying characteristics	Full sample N = 412		Drinkers only N = 335	
	HR (95% CI)	AHR (95% CI)	HR (95% CI)	AHR (95% CI)
Per unit increase in Average drinks per week	0.99 (0.96, 1.02)	1.00 (0.96, 1.04)		
Per unit increase in Alcohol consequences			1.15 (1.02, 1.29)	1.19 (1.05, 1.34)
Don't get along with roommate	2.03 (1.22, 3.38)	2.14 (1.25, 3.66)	2.07 (1.11, 3.86)	2.20 (1.08, 4.49)
Per unit increase in Social connectedness	0.50 (0.42, 0.61)	0.50 (0.41, 0.62)	0.48 (0.38, 0.61)	0.50 (0.37, 0.67)
Use marijuana	1.30 (0.81, 2.08)	1.69 (0.95, 3.02)	1.17 (0.67, 2.05)	1.09 (0.55, 2.15)
Challenging academic expectations	1.38 (0.64, 3.00)	1.67 (0.75, 3.73)	1.93 (0.60, 6.19)	1.70 (0.50, 5.74)
Time-fixed characteristics				
Sexual victimization prior to college	1.90 (1.15, 3.14)	2.14 (1.18, 3.86)	2.23 (1.24, 3.98)	1.92 (0.89, 4.13)
Socioeconomic status				
low	1.00	1.00	1.00	1.00
middle	0.90 (0.56, 1.45)	0.89 (0.52, 1.53)	0.70 (0.39, 1.26)	0.50 (0.24, 1.06)
high	0.92 (0.51, 1.66)	1.13 (0.59, 2.18)	0.90 (0.45, 1.79)	0.86 (0.37, 2.02)
White, non-Hispanic	0.85 (0.56, 1.30)	1.04 (0.63, 1.73)	0.97 (0.56, 1.66)	1.00 (0.48, 2.06)

Abbreviations: MDD, major depressive disorder; HR, bivariate hazard ratio; AHR, adjusted hazard ratio.
Bold font indicates significant results at $\alpha = 0.05$.

0.38–0.61).

In the multivariable Cox proportional hazards regression model (Table 3), average drinks per week was not associated with the onset of MDD (adjusted hazard ratio [AHR] = 1.00; 95% CI: 0.96–1.04). Sensitivity analyses supported these findings, as both crude and adjusted effect estimates were not significant for heavy episodic drinking, when introducing a 2-month lag, or when assessing for cumulative exposure over time (Table 4). In addition, when allowing for a quadratic relationship, neither the linear term nor quadratic term for average drinks per week were significant.

Alcohol consequences were prospectively associated with the onset of MDD among drinkers (AHR: 1.19; 95% CI: 1.05–1.34). In the final models, not getting along with one's roommate remained positively associated with onset of MDD (full sample AHR: 2.14; 95% CI: 1.25–3.66, drinkers only AHR: 2.20; 95% CI: 1.08–4.49) and social connectedness remained negatively associated with onset of MDD (full sample AHR: 0.50; 95% CI: 0.41–0.62, drinkers only AHR: 0.50; 95% CI: 0.37–0.67). Sexual victimization prior to college was positively associated with the onset of depression among the full sample (AHR: 2.14;

Table 4
Secondary and sensitivity analyses examining the effect of alcohol consumption and heavy episodic drinking on the risk of major depressive disorder among female first-year college students.

Time-varying exposure	Full sample N = 412	
	HR (95% CI)	AHR ^a (95% CI)
Per unit increase in Cumulative Avg. drinks per week	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
Per unit increase in Avg. drinks per week - 2 month lag	1.00 (0.96, 1.04)	1.02 (0.98, 1.06)
Per unit increase in heavy drinking episodes	0.95 (0.88, 1.02)	0.94 (0.86, 1.04)
Per unit increase in Cumulative heavy drinking episodes	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)
Per unit increase in heavy drinking episodes - 2 month lag	1.00 (0.93, 1.07)	1.03 (0.95, 1.13)

Abbreviations: MDD, major depressive disorder; HR, bivariate hazard ratio; AHR, adjusted hazard ratio

Bold font indicates significant results at $\alpha = 0.05$.

^a Adjusting for time-varying: not getting along with roommate, social connectedness, smoking marijuana, challenging academic expectations, and time-fixed: Sexual victimization prior to college, socioeconomic status, and race/ethnicity

95% CI: 1.18–3.86), but was not significant in the final model that included alcohol consequences (AHR: 1.92; 95% CI: 0.89–4.13). When allowing for a quadratic relationship between alcohol consequences and onset of MDD, neither the linear term nor the quadratic term for alcohol consequences were significant. Finally, when adjusting for alcohol consumption, alcohol consequences still predicted onset of MDD.

4. Discussion

In this longitudinal study of female students with no history of depressive disorder, 23% experienced symptoms indicative of new onset MDD during their first year of college. The high incidence of MDD among females corroborates prior reports. For example, in 2011, the American College Health Association found that 34% of female college students reported symptoms of depression in the past year (American College Health Association, 2011).

We hypothesized that higher levels of alcohol consumption would increase the risk of new onset depression. The evidence did not support this hypothesis, as average drinks per week was not associated with the onset of depression, including after adjustment for potential confounders including sexual victimization prior to college, SES, not getting along with one's roommate, social connectedness, marijuana use, and challenging academic expectations. The lack of association between alcohol consumption and the onset of MDD was also observed when examining the impact of heavy episodic drinking, when introducing a 2-month lag between exposure and the onset of MDD, and when assessing cumulative exposure of both average drinks per week and heavy episodic drinking. These findings contrast with prior results that have identified alcohol consumption as being associated with risk of depression (McEachin et al., 2008; Paljarvi et al., 2009; Sihvola et al., 2008).

One explanation for the differences between this and prior studies is that ours is one of the few that have examined the relationship prospectively, and is the only study that has examined the relationship with high-resolution (i.e., monthly) assessments. It is possible that the effect of alcohol consumption on the onset of MDD takes longer than the duration of a school year; indeed, one of the few studies that prospectively examined the alcohol consumption–MDD relationship found an association between observed participants over five years (Paljarvi et al., 2009).

Another explanation for our findings may be that our sample comprised 18–20 year-old females (primarily white and of middle/high SES) completing their first year of college. Because the modal background reflected a privileged SES and women were attending a private

university, they may enjoy stronger social support networks than other college students. This potential explanation of the findings aligns with the “buffering hypothesis”—the notion that social support protects against adverse effects of stressful events (Cohen & Wills, 1985).

We found that female students who experienced more negative consequences from alcohol were at greater risk for the onset of depression, even after adjustment for consumption and potential confounders. Given alcohol consequences was measured as a count from one to 12, and the mean number of drinking consequences reported ranged from 1.52 to 2.10 per month, results suggest even a low number of consequences puts first-year female college students at risk for MDD. Other studies have found cross-sectional associations between substance use consequences and depression (Dennhardt & Murphy, 2011; Weitzman, 2004); yet, to our knowledge, this is the first to examine this relationship prospectively and specifically among first-year college females.

More research is needed to examine the factors that increase the likelihood that college-aged women will experience alcohol consequences. Other studies have found that those who are more impulsive (Kuntsche et al., 2005), use alcohol to cope with negative affect (Neal & Carey, 2007), or lack self-regulation skills (Cooper et al., 1995) are at greater risk of experiencing alcohol consequences. Since lack of social connectedness, not getting along with one's roommate, and prior sexual victimization prior to college were all significant predictors of MDD, it is plausible that coping motives are the mechanism by which these lead to MDD. For example, coping motives have been shown to increase risk for depression (Davis et al., 2010). An understanding of the underlying risk factors for alcohol-related consequences, and therefore increased MDD risk, should be used to identify those at-risk and in need of targeted alcohol education and mental health interventions during the first year of college.

Our results suggest that first-year female students who engage in heavy episodic drinking may not necessarily be at increased risk of developing MDD. Rather, those at increased risk for depression are likely to have experienced adverse consequences from their drinking. Many individual- and group-level interventions have been developed to address alcohol misuse among first-year college students. Interventions that address both alcohol consumption and consequences should be implemented to reduce the incidence of MDD. Interventions with personalized feedback, moderation strategies, expectancy challenge, identification of risky situations, and goal-setting optimize the efficacy of such interventions (Barnett et al., 2007; Carey et al., 2011; Murphy et al., 2010). Our findings suggest that interventions that address vulnerability to alcohol consequences are also needed.

A recent study found that among college students with MDD, only 29% were undergoing treatment, and only 44% had undergone treatment in the past year (Eisenberg et al., 2011). Similarly, the American College Health Association found that only 24% of college students diagnosed with depression were receiving treatment (Blanco et al., 2008), and those with a co-morbid alcohol use disorder were less likely to receive treatment (Simons & Carey, 2006). Given these findings, it may be worthwhile to assess alcohol consequences as a screening tool for depression risk among women, particularly in the first year of college. By identifying students who begin to miss class, have declining grades, or are cited for drinking, health care providers can simultaneously target alcohol education and mental health care.

Several limitations of our research should be noted. The sample consisted of predominantly white, higher SES, female students from one university, potentially limiting the generalizability of the results. Future work should sample more diverse student groups as well as non-college attending emerging adults. Second, we used the PHQ-9 rather than a full diagnostic interview. Regardless, misclassification is likely minimal because the validity of the PHQ-9 has been established across settings and has a sensitivity and specificity of 88% for major depression (Kroenke et al., 2001), the potential for misclassification remains. Also, despite being adapted from validated alcohol consequence measures,

the specific measure used in this study was not validated, though good internal consistency was found. Since alcohol consequences were not assessed at baseline, it is unclear if students experienced these prior to starting college and new onset MDD cases at the second assessment had to be excluded from the drinkers only sample. This likely led to an underestimation in the effect between alcohol consequences and onset MDD since power and incidence of MDD decreased as a result. In addition, potential unmeasured confounders may exist. Our analyses did not account for family history of depression and having an alcohol use disorder. Finally, self-report data are subject to recall and social desirability biases. College students may under-report drinking and harms from drinking (Davis et al., 2010); however, these under-reports tend not to be associated with specific sociodemographic characteristics. The likely effect of this is an underestimation of the effect between alcohol consumption (and consequences) and depression. In an attempt to address this concern, the study used web-based surveys, a mode known to reduce social desirability bias and increase the level of reporting of sensitive information relative to other survey modes (Kreuter et al., 2008).

5. Conclusions

In summary, among females during the first year of college, alcohol consumption did not predict incident MDD. However, alcohol consequences did increase the risk of incident MDD during the study year. Substance use and mental health interventions should aim both to reduce alcohol consumption and to target alcohol-related consequences. Screening for alcohol consequences may help identify women at risk for MDD and help more students get the mental health care they need. Finally, more research should be conducted to understand who is at increased risk for experiencing alcohol consequences—and this information should be incorporated into alcohol education and mental health programming.

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