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## Sex differences in college student adherence to NIAAA drinking guidelines

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### Abstract

**Background**—Exceeding nationally recommended drinking limits puts individuals at increased risk of experiencing harmful effects due to alcohol consumption. Both weekly and daily limits exist to prevent harm due to toxicity and intoxication, respectively. It remains unclear how well college students adhere to recommended limits, and if their drinking is sensitive to the wider sex difference in weekly vs. daily drinking limits.

**Methods**—This study used a daily-level, academic-year-long, multi-site sample to describe adherence to NIAAA daily (no more than 4 drinks per day for men, 3 drinks per day for women) and weekly (no more than 14 drinks per week for men, 7 drinks per week for women) drinking guidelines, and to test for sex differences and time effects. College students ( $n=992$ ; 58% female) reported daily drinking on a biweekly basis using web-based surveys throughout their first year of college.

**Results**—Women exceeded weekly limits more frequently (15% of weeks [14–17%]) than men (12% [10–14%]). Women and men exceeded daily drinking limits similarly often (25% and 27%, respectively). In a GEE analysis across all 18 biweekly assessments, adjusted for covariates and a linear trend over time, women were more likely to exceed weekly guidelines compared to men. Sex differences in exceeding daily limits were not significant. Over time, rates of exceeding limits declined for daily limits but only for males for weekly limits.

**Conclusions**—Female college students are more likely to exceed weekly alcohol intake limits than men. Furthermore, trends over time suggest that college students may be maturing out of heavy episodic drinking, but women may not mature out of harmful levels of weekly drinking.

The observed disparity in risk for long-term health consequences may represent a missed opportunity for education and intervention.

## Keywords

college students; alcohol; drinking guidelines; sex differences

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## Introduction

Exceeding nationally recommended drinking levels puts individuals at increased risk of experiencing harmful effects due to alcohol consumption. Both weekly and daily limits exist, which seek to prevent harm due to toxicity and intoxication, respectively. The NIAAA drinking guidelines (National Institute on Alcohol Abuse and Alcoholism, 2009) define low-risk drinking as drinking no more than 4 drinks per day, and 14 drinks per week for men, and 3 drinks per day, and 7 drinks per week for women. As such, the daily limits are in line with the commonly used cut-offs for heavy episodic drinking (i.e., 5+/4+ drinks for men/women), and both limits are in line with the 2010 Dietary Guidelines for Americans, where drinking in excess of these two limits is defined as “heavy or high-risk drinking” (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010).

The goal of existing guidelines is two-fold: to prevent immediate harm and consequences and to prevent long-term harmful effects. Daily limits indicate a level of alcohol intake above which substantial cognitive and physiological impairment is increased in most adults (Dawson et al., 1996; Hindmarch et al., 1991), and thus may lead to injuries and deaths through burns, drownings, homicides, assaults, falls, and motor vehicle crashes. Weekly limits reflect levels of average daily ethanol intake above which risks of various chronic health conditions are elevated (e.g., Greenfield, 2001), such as liver disease, heart disease, sleep disorders, and several types of cancer.

College student drinking patterns more commonly lead to acute effects including deaths, injuries, and physical and sexual assaults (Dejong et al., 2009; Hingson et al., 2009; NIAAA, 2002) rather than chronic conditions. Further, while there is considerable effort from NIAAA itself to educate college students, health educators, and counselors about the guidelines in their self-help materials (e.g., <http://www.collegedrinkingprevention.gov/OtherAlcoholInformation/tipsForCuttingDownonDrinking.aspx#keepingtrack>; <http://www.collegedrinkingprevention.gov/OtherAlcoholInformation/cutDownOnDrinking.aspx>) and in manuals designed for use by health care providers (<http://www.collegedrinkingprevention.gov/media/FlemingManual.pdf>), many college and university programs and websites discuss responsible drinking in terms of setting a limit for the night, but not for the week. Likewise, more general, non-university-affiliated online safety tips focus on drinking episodes not weekly limits. Even intervention and prevention efforts tend to focus solely on daily limits, and may not even mention weekly limits. For example, the often used Brief Alcohol Screening and Intervention for College Students (BASICS) (e.g., Turrisi et al., 2009) does not educate students about NIAAA drinking limits, nor do AlcoholEdu or e-Chug, the two most widely adopted electronic interventions (Hustad et al., 2010), or some brief motivational interviewing approaches (e.g., Wood et al.,

2010). Even norms perception approaches (e.g., LaBrie et al., 2008; Neighbors et al., 2010), which oftentimes provide weekly drinking norms, do not educate students about NIAAA recommended cutoff limits to prevent harmful effects. Thus, college students are more likely to be familiar with heavy episodic drinking guidelines than nationally recommended weekly drinking limits that would minimize their chances of developing chronic conditions in the long term.

A complicating factor is that the national drinking guidelines are sex-specific, and that the gap in low-risk drinking between men and women is larger for the weekly than the daily limits. That is, the NIAAA drinking guidelines recommend that, per day, women should drink no more than 75% of the recommended limit for men (i.e., 3 vs. 4 drinks per day), while per week, women should drink no more than 50% of the recommended limit for men (i.e., 7 vs. 14 drinks per week).

Currently, it is not well understood how frequently college students exceed weekly drinking limits or whether female students may be at greater risk of exceeding these limits. Generally, alcohol use is more common among men relative to women (e.g., O'Donnell et al., 2006; Wechsler et al., 1994), and can result in different negative consequences of drinking for men and women (Norberg et al., 2011). Sex differences also exist in drinking motives (e.g., Park and Levenson, 2002), and to some extent, in daily drinking patterns (Hoeppner et al., 2012). It remains unclear, however, if men and women differ in their adherence to national drinking guidelines. The majority of U.S. adults (~70%) either abstain from alcohol entirely or drink within low-risk limits (NIAAA, 2009). These numbers are likely to be lower among college students, given the high frequency of heavy episodic drinking, with 37% of full-time college students reporting having consumed five or more drinks in a row in the last two weeks (Johnston et al., 2012). National surveys do not, however, typically report the frequency with which weekly limits are exceeded in this population.

In this study, we examined 18 biweekly reports by 992 first year college students of their daily drinking during the previous week. Our objective was to describe overall prevalence levels of exceeding daily and weekly drinking limits (i.e., whether or not students exceeded guidelines during the first year; how frequently they exceeded guidelines; if there were changing trends over time in exceeding guidelines), and to test for potential sex differences in exceeding guidelines.

As a thought experiment, we also looked at a second weekly cutoff for women. If college students are knowledgeable about the heavy episodic drinking definitions (i.e., 5+/4+ drinks), but are not knowledgeable about weekly drinking limits, then women might be expected to drink less than men, but at a rate of 80% ( $4/5=0.80$ ) of men's consumption, rather than at the recommended weekly rate of 50% ( $7/14=0.50$ ). If that were the case, women might drink no more than 11 drinks per week, i.e. 80% of men's consumption. To test this idea, we examined how frequently women exceeded 11 drinks per week, and if they did so at the same rate as men exceeded 14 drinks per week.

## Materials and Methods

### Participants

Participants were incoming first-year college students, who were recruited during the summer to participate in a two-year longitudinal study to evaluate naturalistic changes in alcohol use for typical college students (43% recruitment rate). Recruitment occurred in three cohorts, in the summers of 2004, 2005 and 2006. Students were eligible to participate if they attended high school in the U.S., planning to live on campus in college, and enrolled at one of three participating New England universities and colleges. Participants were included in the present analyses if they completed at least 1 biweekly report after their baseline assessment (94%). The sample ( $n=992$ ) was on average 18.4 ( $SD=0.5$ ) years old at enrollment and was 58.4% female. Participants reported their race as White (64.5%), Asian (13.6%), African American (7.5%), Pacific Islander (0.3%), American Indian (0.1%), and multi-racial (6.0%); 7.7% did not specify their racial background and 12.0% reported being Hispanic.

### Procedure

Incoming students received letters inviting them to enroll in the study, and parents of minors received similar letters. Participants completed an online consent procedure, followed by a baseline assessment battery prior to arriving on their college campus. Starting with the first week after arrival on campus, participants received biweekly emails containing links to an online survey. Participants were given one week to complete each survey, and were reminded twice to do so via email. Surveys were conducted throughout the school year, including breaks, resulting in 18 possible surveys in the academic year. Biweekly reports rather than weekly reports were used to reduce response burden. All procedures were approved by the Institutional Review Boards of the participating institutions.

### Measures

**Alcohol Use**—For the biweekly reports, students completed a 7-day timeline follow-back of the number of drinks they consumed each day (Hoepfner et al., 2010). The online survey link provided a grid with dates for the seven days prior to the survey completion, starting with yesterday. Thus, for each respondent there was a flexibly-timed 7-day recall period during every *a priori* determined 14-day interval. For each 7-day recall period, we derived binary indicators of exceeding NIAAA drinking guidelines during that week.

**Pre-college characteristics**—The baseline assessment battery assessed demographics (i.e., age, sex, race), and included a scale measuring drinking during the senior year in high school (a modified version of the Graduated Frequency for Alcohol; Hilton, 1989; Rehm et al., 1999), from which we derived the average number of drinks consumed per week in the senior year of high school. Given the zero-inflation and skew of this variable, we created three categories: no alcohol use (58%), one drink per week or less (13%), and more than one drink (29%).

## Analytic Strategy

To describe the prevalence of exceeding NIAAA drinking guidelines in college students, we examined different ways in which students could exceed these limits: by exceeding either daily or weekly limits, by exceeding both, by exceeding daily limits (regardless of weekly limits), and by exceeding weekly limits (regardless of daily limits). For these indices, we calculated the proportions of students who ever exceeded NIAAA drinking guidelines in the first year of college. Then, to determine the frequency of exceeding limits, we calculated the average proportion of weeks during which college students exceeded guidelines (i.e., we first calculated the proportion of weeks each student exceeded guidelines, and then averaged across students). For descriptive comparison, we calculated these values for women and men separately, and calculated proportions first based on all students and then based on only students who drank at least one drink during the first year. To graphically describe trends over time, we also calculated the proportions of student who exceeded drinking guidelines each week.

To test for sex differences in exceeding drinking guidelines over time, we used generalized estimating equations (GEE) (Liang and Zeger, 1986), where the binary dependent variable, “exceeding drinking guidelines (vs. not)”, was measured 18 times per participant. Using SAS proc genmod, we modeled this dependent variable using a binomial distribution, used the log link rather than the logit link function to calculate relative risks (Carter et al., 2009), and used a first-order autoregressive structure (AR1) to model serial dependence. We protected the chosen alpha of 0.05 in the presence of multiple significance testing (i.e., five dependent variables) by adjusting *p*-values based on the expected proportion of falsely rejected hypotheses, as described by Benjamini and Hochberg (1995).

As a preliminary step, we used the same approach to test for significant predictors of missing observations, where we tested demographic (i.e., sex, race, age), logistical (i.e., school of enrollment, linear trend for time), and prior alcohol use (i.e., number of drinks per week during a typical week in high school) variables. We included significant predictors of non-response in the GEE model of exceeding NIAAA drinking guidelines alongside sex, our predictor of interest. We included logistical variables regardless of significance, because we wanted to account for differences between schools, and because we wanted to know if rates of exceeding drinking guidelines increased or decreased over time.

## Results

### Compliance with Biweekly Assessments

Participants reported data on average on  $112 \pm 27.5$  days (median=126, min=7, max=126) of the possible 126 days, and  $16 \pm 3.9$  weeks (median=18, min=1, max=18) of the possible 18 weeks. In any given week, non-response ranged from 7.8% (biweekly interval #5) to 16.0% (biweekly interval #9). Sporadic non-responses (e.g., providing data for fewer than seven days within the one-week recall period) occurred in only 24 (2.4%) participants, for a total of 32 weekly reports (< 1% of the 17,856 possible weekly reports).

Significant predictors of non-response were race ( $\chi^2(1) = 20.13, p < .05$ ), where non-Hispanic Whites were less likely to complete biweekly reports; school ( $\chi^2(2) = 49.51, p < .$

05), and prior alcohol use ( $\chi^2(2) = 35.75, p < .05$ ), where students who drank more drinks during a typical week during high school were less likely to complete a given biweekly report. There was no increasing or decreasing trend in biweekly survey completion across the first year of college ( $\chi^2(1) = 1.68, p > .05$ ), and age ( $\chi^2(1) = 0.93, p > .05$ ) and sex ( $\chi^2(1) = 1.46, p > .05$ ) appeared to be unrelated to biweekly non-response. Similarly, interaction effects between sex and the other potential predictors of non-response were not significant.

Given the rarity of sporadic non-response, the lack of a systematic link between non-response and the passage of time, and the fact that even partial information improves model estimates, we included all participants in the analyses, even those with only 1 or 2 weeks of data (2.4%).

### Prevalence of Exceeding NIAAA Guidelines

The prevalence of exceeding NIAAA drinking guidelines (either weekly or daily or both) at least once during the first year of college (Table 1) was fairly high, both among all students (65.6%) and certainly among non-abstaining students (85.4%). Among drinkers, a larger proportion of men than women exceeded NIAAA drinking guidelines (88.9% vs. 83.2%). When looking at daily and weekly limits separately, more women than men exceeded weekly limits (60.7% vs. 64.8%, for males and females respectively). No student exceeded weekly limits without also exceeding daily limits during that year. Even when examining each week separately, we found that few students exceeded weekly but not daily limits in a given week, and if they did, only once ( $n=27$ ) or twice ( $n=4$ ) during the year.

Across the 18 biweekly assessments (Table 2), men and women exceeded the daily drinking limit similarly frequently (during 27% and 25% of the 18 weeks on average, respectively), including among ever drinkers (37% and 32%, respectively). Women tended to exceed weekly limits more frequently than men (15% of weeks for women vs. 12% of weeks for men). Regarding our thought experiment, note that women exceeded 11 drinks per week (8% of weeks) less frequently than men exceeded 14 drinks per week. The same pattern emerged among ever drinkers (10% versus 16%).

For both daily and weekly drinking, prevalence rates fluctuated by week, apparently in response to academic calendar events (Figure 1). For example, drinking guidelines were less commonly exceeded during winter break weeks. Nevertheless, two general trends emerge. In any given week, more men tended to exceed daily limits than women, except towards the end of the academic year, when rates were quite similar. For weekly drinking, female students exceeded weekly limits more commonly than male students.

### Testing Sex Differences in Exceeding NIAAA Drinking Guidelines

Among all students, and after adjusting for covariates, sex differences (Table 3) in exceeding NIAAA drinking guidelines in general (either weekly or daily or both) were not significant ( $\chi^2(1)=3.48, p>.05$ ), but they were significant for exceeding both daily and weekly limits in the same week ( $\chi^2(1)=29.07, p<.01$ ), where women were 1.54 times as likely to exceed both daily and weekly limits in the same week as men. This difference was



largely due to differences in exceeding weekly limits ( $\chi^2(1)=31.61, p<.01$ ), where women were 1.57 times as likely as men to exceed weekly limits. Differences in exceeding daily limits were non-significant ( $\chi^2(1)=1.64, p>.05$ ). Regarding our thought experiment, when considering a weekly limit of 11 drinks for women, no sex differences in exceeding weekly limits were found ( $\chi^2(1)=1.64, p>.05$ ).

When we restricted analyses to ever drinkers only (Table 3), the same pattern of results emerged. That is, women were more likely to exceed both daily and weekly limits in a given week ( $\chi^2(1)=21.72, p<.01$ ), which was largely due to their increased likelihood of exceeding weekly limits ( $\chi^2(1)=23.92, p<.01$ ); no differences emerged regarding exceeding daily limits only ( $\chi^2(1)=0.11, p>.05$ ). Relative risks estimates, however, were somewhat lower in this sub-sample analysis.

All five models included race, school, previous alcohol use and a linear trend over time as covariates. Race, school and previous alcohol use were included in the model because they were significantly related to non-response. In the models predicting exceeding NIAAA drinking guidelines, these predictors were also significant. Specifically, across all five models, and both sample selections, students with higher levels of alcohol consumption in the year before college were more likely to exceed drinking guidelines. In a subset of models (i.e., exceeding NIAAA guidelines in general; daily limits specifically), school was a significant predictor for both sample selections, and race for the all-student analyses only, where non-Hispanic Whites were more likely to exceed NIAAA guidelines in general ( $\chi^2(1)=11.76, p<.05$ ), as well as daily limits specifically ( $\chi^2(1)=11.96, p<.05$ ).

In both sample selections, there was a significantly decreasing trend over the first year of college in exceeding NIAAA drinking guidelines ( $\chi^2(1)=11.45$  and  $10.78$ , respectively,  $p<.05$ ), which was largely due to decreasing trends in exceeding daily limits ( $\chi^2(1)=12.23$  and  $11.55$ , respectively,  $p<.05$ ). This trend was small, with a relative risk estimate of 0.991 per month in both sample selections, but does translate into an average decline in exceeding daily limits in any given week by approximately 10% by the end of the first year. In post-hoc analyses, sex differences in trends over time, as indicated by a significant interaction term between sex and time, were found for exceeding both limits and weekly limits (all students:  $\chi^2(1)=5.98$  (both) and  $6.14$  (weekly); ever drinkers:  $\chi^2(1)=6.07$  (both) and  $6.23$  (weekly), where men showed a decreasing trend in exceeding weekly limits (RR=0.98 [0.97–0.99]) in both sample selections, while women did not.

## Discussion

This study used multiple weekly recall periods across the first year of college to examine how commonly and frequently college students exceeded the NIAAA drinking guidelines. It should be noted that some controversy exists regarding the presence or size of the sex difference in alcohol related harm. For example, meta-analyses suggest smaller sex differences than those used by national guidelines (Corrao et al., 2000; Gmel et al., 2003). The specific values of the NIAAA weekly limits, however, are in line with evidence that indicates that women are at risk of developing long-term harmful effects at lower levels of alcohol intake than men, particularly for liver disease and breast cancer. For example, the

14/7 weekly drinking guidelines are in line with findings from a large population-based prospective study with 12-year follow-up that showed that the relative risk of developing alcohol-related liver disease was increased at 7 to 13 drinks per week for women and 14 to 27 drinks per week for men (Becker et al., 1996). They are also in line with findings from breast cancer research, where recent evidence suggests that the relative risk of developing breast cancer over nondrinkers may be increased at even lower levels of drinking, namely, at 3–6 drinks per week (Chen et al., 2011). Thus, while there is some controversy about what the sex-specific drinking guidelines should be, evidence exists that supports the weekly NIAAA drinking guidelines.

Our results indicate that, in any given week, college students are more likely to exceed daily limits than weekly limits, as would be expected given national data. Specifically, Monitoring the Future (MTF) and National Household Survey of Drug Abuse (NHSDA) data indicate that college students have higher prevalence rates of alcohol use and higher rates of heavy episodic use, but lower rates of daily drinking than their non-student peers (Johnston et al., 2012; O'Malley and Johnston, 2002).

Given the sex-specificity of the national guidelines, and the wider gap between limits for men and women in daily vs. weekly guidelines, we tested if there were sex differences in exceeding these guidelines. We found that women were more likely to exceed the weekly limits suggested by the NIAAA drinking guidelines (i.e., drink more than 7 drinks in a week) than men, whose weekly limit is substantially higher (i.e., no more than 14 drinks in a week). Men and women were similarly likely to exceed daily limits, after adjusting for race, school, pre-college drinking and a linear trend over time. This finding of differences in weekly but not daily drinking suggests that, if the 14/7 criteria are valid, women are at greater risk than men of engaging in drinking habits during college that are more likely to result in long-term harm. If this trend continued beyond the college years, this pattern of drinking could put women at increased risk of experiencing toxicity-related harm in later years.

Fortunately, many college students mature out of heavy episodic drinking after college (Dawson et al., 2004). To the degree that the drinking behavior of exceeding weekly limits is merely an artifact of exceeding daily limits, and thus similarly likely a habit that students mature out of, the harmful effects due to alcohol toxicity during the college years is likely limited. It should be noted though that brain development continues well into the early adulthood years. The potential long-term consequences of alcohol use during this time of rapid developmental processes are not yet well understood, but rapidly changing systems are often particularly vulnerable to disruption (Spear, 2002). Also of concern is recent evidence that suggest that although heavy drinking declines upon college graduation, drinking frequency remains stable or even increases (Johnston et al., 2012); this raises the possibility that the weekly limits become more relevant after leaving the college environment when weekly volume is less likely to be driven by heavy episodic drinking.

We showed linear decreases in exceeding daily limits for both men and women over the course of the first year of college, but for weekly limits, we only showed decreases in men but not women. With women's greater tendency to exceed weekly guidelines than men, there



may be long-term implications for women in particular. Women may fail to mature out of this potentially harmful drinking pattern; for example, after college, young women might drink 1 drink per day with a meal, and 2 on weekends (equaling 9 drinks per week), thinking it to be safe (i.e., below the 3 drinks per day daily limit), when in fact it is not from the standpoint of toxicity. It would be easy for young women to make this mistake, because college student drinkers are almost exclusively exposed to information about the dangers of intoxication due to heavy episodic drinking, and receive little if any education about the long-term harmful effects due to toxicity and the need to manage the overall volume of alcohol. Existing college student drinking prevention and intervention efforts come in a wide variety of forms, including correcting norms perception, motivational interviewing and educational approaches, but are generally united in their omission of addressing weekly drinking limits, though notable exceptions exist (Borsari et al., 2007; 2012).

Study findings suggest a need to include information about weekly limits in ongoing college alcohol harm preventions strategies, and it will be crucial to understand why women exceed these limits. Our data, unfortunately, cannot address this point directly. One possibility is that this tendency is due to lack of awareness on the part of women: when we compared the rates men exceeded 14 drinks per week with the rates women exceeded 11 drinks per week, the 80% equivalent of men's weekly limit, we found no sex differences. This finding suggests that women know to drink less than men, but they may not know how much less they should drink weekly to prevent toxicity effects. Lack of awareness of the qualitatively different weekly drinking limits, however, is not the only explanation of this finding. It is quite possible that women had knowledge of their recommended weekly drinking limit but still drank at levels exceeding the weekly limit, perhaps motivated by contextual influences by peers (e.g., active or passive influences) or alcohol cue exposure. In line with that idea is the observation that students generally exceeded both daily and weekly limits, and rarely if ever exceeded just weekly limits. On the other hand, the finding of no sex differences in exceeding the 14/11 drinks cut-offs, combined with the finding that rates of daily excesses decreased over the study duration, while weekly excesses did not, at least suggests that lack of knowledge may play a role in college women exceeding NIAAA weekly drinking limits more commonly and more frequently than men. Lastly, we cannot rule out the possibility that the guidelines are simply incorrect. The intent of the present paper is not to make conclusions regarding the accuracy of the guidelines (nor would we be able to with the existing data), but simply to raise awareness at the inconsistency when considering gender differences.

The complexity of these reasons and caveats notwithstanding, it seems advisable to consider including information about NIAAA weekly drinking limits in college alcohol intervention strategies. The current focus on heavy episodic drinking arises from the continuing need to address and prevent the acute harm caused by heavy episodic drinking in this population (Dejong et al., 2009; Hingson et al., 2009), but perhaps this focus need not be to the exclusion of educating college students about overall weekly drinking limits and long term risks of alcohol consumption. Complicating factors are the need for brevity and the need to minimize resistance. For many at-risk drinkers, the NIAAA drinking guidelines may seem unrealistically low, and could potentially result in the loss of credibility. Nevertheless, excluding weekly limits from discussion could be a missed opportunity for lifelong teaching.

Educating college students about weekly limits may not impact their drinking behaviors during college, given social pressures and norms, but using this opportunity to impart important health information could positively impact the rest of their lives.

### Strengths and Limitations

This study is the first to explore sex differences in exceeding weekly drinking limits in a college student population. It used a large, multi-campus sample, recruited over several cohorts, thereby increasing the generalizability of results. Fine-grained longitudinal data collection methods minimized recall biases (Hoeppner et al., 2010) and spanned a long period of time (i.e., an academic year in its entirety), and enabled the identification of trends over time, including the percentage of weeks during which students exceeded guidelines, not just point-estimates of prevalence levels.

Results must also be understood within the context of several limitations. Racial and ethnic diversity in our sample, while representative of the participating universities and colleges, did not provide large enough groups for subgroup analyses. Additionally, retention over time, while generally high (87–92% each week), was systematically related to alcohol use, such that students with higher pre-college alcohol use were less likely to complete biweekly surveys. Thus, our estimates of alcohol use are likely underestimates. Importantly, however, survey non-response was not related to sex, thereby lessens the worry that sex differences may be confounded with survey non-response. There was also no decreasing trend in survey completion over time, thereby alleviating worry that the observed declining trend in exceeding daily limits is merely an artifact of non-response. It should also be noted that compliance within each weekly recall period (i.e., reporting of each day's drinking) was excellent (>99%), so that each weekly estimate was based on complete information.

### Conclusions

Our results indicate that female college students, compared to their male counterparts, are more likely to exceed the weekly alcohol intake limits recommended by the NIAAA (2009), thereby putting themselves at increased risk for experiencing long-term alcohol-related harm due to toxicity. No such differences were observed with respect to heavy episodic drinking. Moreover, while rates of exceeding daily limits declined over the first year of college, they did not do so for weekly limits, suggesting that college students may be maturing out of heavy episodic drinking, but not harmful weekly drinking. Most college student drinking interventions (e.g., including norms perception, motivational interviewing and educational approaches) do not typically educate students about weekly drinking limits. Our findings suggest that the observed disparity in risk for long-term health consequences via excessive weekly drinking may represent a missed opportunity for lifelong education and intervention, particularly for women.

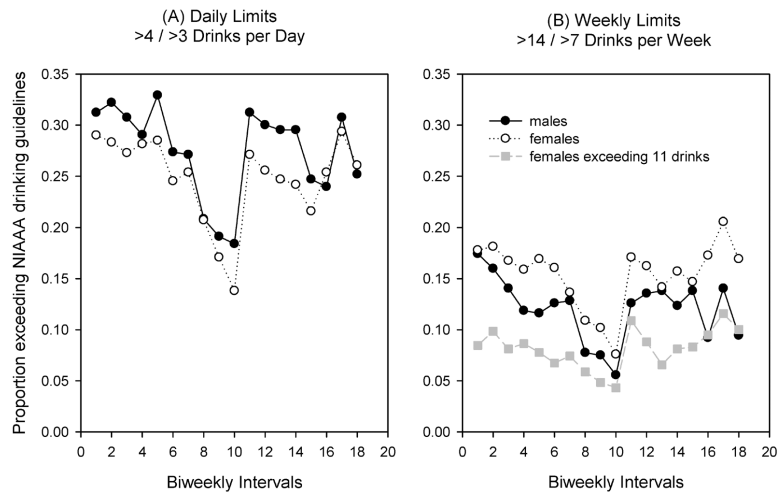
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## References

- Becker U, Deis A, Sorensen TI, Gronbaek M, Borch-Johnsen K, Muller CF, Schnohr P, Jensen G. Prediction of risk of liver disease by alcohol intake, sex, and age: a prospective population study. *Hepatology*. 1996; 23:1025–1029. [PubMed: 8621128]
- Benjamini Y, Hochberg Y. Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *J R Stat Soc Ser B Methodol*. 1995; 57:289–300.
- Borsari B, Hustad JT, Mastroleo NR, Tevyaw TO, Barnett NP, Kahler CW, Short EE, Monti PM. Addressing alcohol use and problems in mandated college students: A randomized clinical trial using stepped care. *J Consult Clin Psychol*. 2012; 80:1062–1074. [PubMed: 22924334]
- Borsari B, O'Leary Tevyaw T, Barnett NP, Kahler CW, Monti PM. Stepped care for mandated college students: a pilot study. *Am J Addict*. 2007; 16:131–137. [PubMed: 17453615]
- Carter RE, Zhang X, Woolson RF, Apfel CC. Statistical analysis of correlated relative risk. *JDS*. 2009; 7:397–407.
- Chen WY, Rosner B, Hankinson SE, Colditz GA, Willett WC. Moderate alcohol consumption during adult life, drinking patterns, and breast cancer risk. *JAMA*. 2011; 306:1884–1890. [PubMed: 22045766]
- Corrao G, Rubbiati L, Bagnardi V, Zambon A, Poikolainen K. Alcohol and coronary heart disease: a meta-analysis. *Addiction*. 2000; 95:1505–1523. [PubMed: 11070527]
- Dawson DA, Archer LD, Grant BF. Reducing alcohol-use disorders via decreased consumption: a comparison of population and high-risk strategies. *Drug Alcohol Depend*. 1996; 42:39–47. [PubMed: 8889402]
- Dawson DA, Grant BF, Stinson FS, Chou PS. Another look at heavy episodic drinking and alcohol use disorders among college and noncollege youth. *J Stud Alcohol*. 2004; 65:477–488. [PubMed: 15378804]
- Dejong W, Larimer ME, Wood MD, Hartman R. NIAAA's rapid response to college drinking problems initiative: reinforcing the use of evidence-based approaches in college alcohol prevention. *J Stud Alcohol Drugs Suppl*. 2009;5–11. [PubMed: 19538907]
- Gmel G, Gutjahr E, Rehm J. How stable is the risk curve between alcohol and all-cause mortality and what factors influence the shape? A precision-weighted hierarchical meta-analysis. *Eur J Epidemiol*. 2003; 18:631–642. [PubMed: 12952136]
- Greenfield, TK. Individual risk of alcohol-related disease and problems, in *International Handbook of Alcohol Dependence and Problems*, International Handbook of Alcohol Dependence and Problems. HEATHER, N.; PETERS, TJ.; STOCKWELL, T., editors. John Wiley & Sons; Chichester, England: 2001. p. 413-437.
- Hilton ME. A Comparison of a Prospective Diary and Two Summary Recall Techniques for Recording Alcohol Consumption. *Br J Addict*. 1989; 84:1085–1092. [PubMed: 2790272]
- Hindmarch I, Kerr JS, Sherwood N. The effects of alcohol and other drugs on psychomotor performance and cognitive function. *Alcohol Alcohol*. 1991; 26:71–79. [PubMed: 1854375]
- Hingson RW, Zha W, Weitzman ER. Magnitude of and trends in alcohol-related mortality and morbidity among U.S. college students ages 18–24, 1998–2005. *J Stud Alcohol Drugs Suppl*. 2009;12–20. [PubMed: 19538908]
- Hoepfner BB, Barnett NP, Jackson KM, Colby SM, Kahler CW, Monti PM, Read J, Tevyaw T, Wood M, Corriveau D, Fingeret A. Daily college student drinking patterns across the first year of college. *J Stud Alcohol Drugs*. 2012; 73:613–624. [PubMed: 22630800]
- Hoepfner BB, Stout RL, Jackson KM, Barnett NP. How good is fine-grained Timeline Follow-back data? Comparing 30-day TLFB and repeated 7-day TLFB alcohol consumption reports on the person and daily level. *Addict Behav*. 2010; 35:1138–1143. [PubMed: 20822852]
- Hustad JT, Barnett NP, Borsari B, Jackson KM. Web-based alcohol prevention for incoming college students: a randomized controlled trial. *Addict Behav*. 2010; 35:183–189. [PubMed: 19900763]
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. *College students and adults ages 19–50*, Institute for Social Research. Vol. Volume II. The University of Michigan; Ann Arbor, MI: 2012. Monitoring the Future national survey results on drug use, 1975–2011.

- LaBrie JW, Hummer JF, Neighbors C, Pedersen ER. Live interactive group-specific normative feedback reduces misperceptions and drinking in college students: a randomized cluster trial. *Psychol Addict Behav*. 2008; 22:141–148. [PubMed: 18298241]
- Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika*. 1986; 73:13–22.
- National Institute on Alcohol Abuse and Alcoholism. Final Report on the Panel on Contexts and Consequences. Task Force on the National Advisory Council on Alcohol Abuse and Alcoholism; U.S. Department of Health and Human Services; Rockville, MD: 2002. High-Risk Drinking in College: What We Know and What We Need To Learn. Final Report on the Panel on Contexts and Consequences. Task Force on the National Advisory Council on Alcohol Abuse and Alcoholism, in Series High-Risk Drinking in College: What We Know and What We Need To Learn.
- National Institute on Alcohol Abuse and Alcoholism. Rethinking Drinking (NIH Publication #09-3770), in Series Rethinking Drinking (NIH Publication #09-3770). U.S. Department of Health and Human Services; Rockville, MD: 2009.
- Neighbors C, Lewis MA, Atkins DC, Jensen MM, Walter T, Fossos N, Lee CM, Larimer ME. Efficacy of web-based personalized normative feedback: a two-year randomized controlled trial. *J Consult Clin Psychol*. 2010; 78:898–911. [PubMed: 20873892]
- Norberg MM, Olivier J, Alperstein DM, Zvolensky MJ, Norton AR. Adverse consequences of student drinking: the role of sex, social anxiety, drinking motives. *Addict Behav*. 2011; 36:821–828. [PubMed: 21481541]
- O'Donnell K, Wardle J, Dantzer C, Steptoe A. Alcohol consumption and symptoms of depression in young adults from 20 countries. *J Stud Alcohol*. 2006; 67:837–840. [PubMed: 17061000]
- O'Malley PM, Johnston LD. Epidemiology of alcohol and other drug use among american college students. *J Stud Alcohol Suppl*. 2002; 14:23–39. [PubMed: 12022728]
- Park CL, Levenson MR. Drinking to cope among college students: prevalence, problems and coping processes. *J Stud Alcohol*. 2002; 63:486–497. [PubMed: 12160108]
- Rehm J, Greenfield TK, Walsh XX, Robson L, Single E. Assessment methods for alcohol consumption, prevalence of high risk drinking and harm: a sensitivity analysis. *Int J Epidemiol*. 1999; 28:219–224. [PubMed: 10342682]
- Spear LP. The adolescent brain and the college drinker: biological basis of propensity to use and misuse alcohol. *J Stud Alcohol Suppl*. 2002; 71:81.
- Turrisi R, Larimer ME, Mallett KA, Kilmer JR, Ray AE, Mastroleo NR, Geisner IM, Grossbard J, Tollison S, Lostutter TW, Montoya H. A randomized clinical trial evaluating a combined alcohol intervention for high-risk college students. *J Stud Alcohol Drugs*. 2009; 70:555–567. [PubMed: 19515296]
- U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2010. 7th ed.. U.S. Government Printing Office; Washington, DC: 2010.
- Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and behavioral consequences of binge drinking in college. A national survey of students at 140 campuses. *JAMA*. 1994; 272:1672–1677. [PubMed: 7966895]
- Wood MD, Fairlie AM, Fernandez AC, Borsari B, Capone C, Laforge R, Carmona-Barros R. Brief motivational and parent interventions for college students: a randomized factorial study. *J Consult Clin Psychol*. 2010; 78:349–361. [PubMed: 20515210]



**Figure 1.** Weekly trends in exceeding NIAAA drinking guidelines are shown separately for exceeding daily (A) and weekly (B) limits. In any given week, more men tended to exceed daily limits than women, except towards the end of the academic year, when rates were quite similar. For weekly drinking, female students exceeded weekly limits more commonly than male students. Women did not, however, exceed 11 drinks more frequently than men exceeded 14 drinks (shown in grey). These trends are relatively consistent across the academic year, despite overall prevalence levels fluctuating in response to academic calendar events (e.g., winter break around week 10).

**Table 1**

Proportion of males and females ever exceeding NIAAA guidelines in the first year

	Male		Female	
	<i>n</i>	%	<i>n</i>	%
All students ( <i>n</i> =992)				
Exceeded NIAAA guidelines (weekly or daily)	271	65.6	380	65.6
Exceeded daily and weekly	184	44.6	293	50.6
Exceeded daily limit	271	65.6	380	65.6
Exceeded weekly limit	185	44.8	296	51.1
♀ Exceeded 80% of men's weekly limit (i.e., 11 drinks)			207	35.8
Ever drinkers (i.e., at least 1 drink during the first year) only ( <i>n</i> =762)				
Exceeded NIAAA guidelines (weekly or daily)	271	88.9	380	83.2
Exceeded daily and weekly	184	60.3	293	64.1
Exceeded daily limit	271	88.9	380	83.2
Exceeded weekly limit	185	60.7	296	64.8
♀ Exceeded 80% of men's weekly limit (i.e., 11 drinks)			207	45.3



**Table 2**

Average proportion of 18 weeks during which NIAAA guidelines were exceeded

	Male		Female	
	%	95% CI	%	95% CI
All students ( <i>n</i> =992)				
Exceeded NIAAA guidelines (weekly or daily)	0.28	[0.25–0.30]	0.25	[0.23–0.28]
Exceeded daily and weekly	0.12	[0.10–0.14]	0.15	[0.13–0.17]
Exceeded daily limit	0.27	[0.25–0.30]	0.25	[0.23–0.27]
Exceeded weekly limit	0.12	[0.10–0.14]	0.15	[0.14–0.17]
♀ Exceeded 80% of men's weekly limit (i.e., 11 drinks)	0.12	[0.10–0.14]	0.08	[0.07–0.09]
Ever drinkers only ( <i>n</i> =762)				
Exceeded NIAAA guidelines (weekly or daily)	0.37	[0.34–0.41]	0.32	[0.29–0.35]
Exceeded daily and weekly	0.16	[0.14–0.19]	0.19	[0.17–0.21]
Exceeded daily limit	0.37	[0.34–0.40]	0.32	[0.29–0.34]
Exceeded weekly limit	0.16	[0.14–0.19]	0.19	[0.17–0.22]
♀ Exceeded 80% of men's weekly limit (i.e., 11 drinks)	0.16	[0.14–0.19]	0.10	[0.09–0.12]

Note: Proportions were first calculated per participant, and then averaged across participants

**Table 3**

Adjusted relative risk estimates for females relative to males across 18 weeks

Dependent Variable	RR	95% CI
All students ( <i>n</i> =992)		
Exceeded NIAAA guidelines	1.10	[1.00 – 1.21]
Exceeded daily and weekly	1.54	[1.32 – 1.81] **
Exceeded daily limit	1.08	[0.98 – 1.20]
Exceeded weekly limit	1.57	[1.34 – 1.83] **
( <i>Women only</i> ) Exceeded 80% of men's weekly limit (i.e., 11 drinks)	0.89	[0.74 – 1.07]
Ever drinkers only ( <i>n</i> =762)		
Exceeded NIAAA guidelines	1.03	[0.94 – 1.13]
Exceeded daily and weekly	1.45	[1.24 – 1.69] **
Exceeded daily limit	1.02	[0.93 – 1.11]
Exceeded weekly limit	1.47	[1.26 – 1.71] **
( <i>Women only</i> ) Exceeded 80% of men's weekly limit (i.e., 11 drinks)	0.83	[0.69 – 0.99]

Note: Models included race, school, time, # of drinks per week during high school and time as covariates.

\*  $p < 0.05$ ,

\*\*  $p < 0.01$  after adjusting for false discovery rate (Benjamini & Hochberg, 1995)