Published in final edited form as:

Am J Addict. 2011 September ; 20(5): 468–475. doi:10.1111/j.1521-0391.2011.00156.x.

Defining “Binge” Drinking as Five Drinks per Occasion or Drinking to a 0.08% BAC: Which is More Sensitive to Risk?

Mark T. Fillmore, PhD and Rebecca Jude, BA

Department of Psychology, University of Kentucky, Lexington, Kentucky

Abstract

Heavy episodic or “binge” drinking is commonly defined as drinking 4–5 drinks per occasion (5/4 definition) or drinking that results in a blood alcohol concentration (BAC) of 0.08%. The present study compared the validity of each binge definition as an indicator of at-risk, problem drinking. 251 college students were classified as non-binge drinkers or as binge drinkers based on the 5/4 definition or the 0.08% BAC definition. The two definitions of binge drinking were examined in terms of their sensitivity and specificity as indicators of alcohol-related problems as determined by scores on the Alcohol Use Disorders Identification Test (AUDIT). Over half the sample (56%) were at-risk drinkers according to the AUDIT. The 0.08% definition detected only one-half of these individuals. Gender differences were also evident. Female binge drinkers actually achieved significantly higher estimated BACs per episode than their male binge drinking counterparts. The findings suggest that drinking to a sub-threshold BAC (i.e., < 0.08%) is not sufficient to avoid alcohol-related problems, and that total quantity (i.e., total standard drinks) per occasion might contribute to risk independent of the BAC achieved during drinking episodes. The findings also highlight the importance of considering frequency of consumption in determining risky drinking versus relying solely on quantity measures.

Introduction

Heavy episodic or “binge” drinking among college students represents a major public health concern and is a leading cause of preventable death on college campuses.¹ Epidemiological studies have identified that binge drinking is widespread on college campuses with some studies indicating approximately 50% of students reporting binge drinking in recent weeks.² One recent study noted that approximately 500,000 college students are injured and 1,700 die each year from alcohol-related injuries.³ Binge drinkers have a greater risk for developing alcohol dependence.⁴ In addition, binge drinking has been associated with unplanned and unsafe sexual activity, assaults, falls, injuries, criminal violations, automobile crashes, and overall poor neuropsychological functioning.⁵

The term “binge” has a long history of use in alcohol research. Jellinek used the term to describe the consumption of a large amount of alcohol over days and weeks.⁶ Today, the term is applied to less extreme drinking, referring to any instance of heavy alcohol use over a short period of time. In an attempt to better operationalize the term, two definitions of binge drinking have emerged in recent years. One commonly used definition is the five/four (5/4) drink definition, in which binge drinking is considered to have occurred after the consumption of five drinks (four drinks for females) on a single occasion.⁷ Its popularity is

Address correspondence to Dr. Fillmore, Department of Psychology, 220B Kastle Hall, University of Kentucky, Lexington, KY 40506-0044. fillmore@uky.edu.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

likely due, in part, to its ease of calculation which only requires a tally of the number of alcoholic drinks consumed during a typical drinking occasion. Yet, despite widespread use of the 5/4 definition there has been some controversy concerning its validity as an indicator of at-risk drinking.^{8–11} The definition is commonly criticized as being an insufficient measure of binge drinking because it does not take into account the drinker's body weight and the duration of the drinking episode.¹² As such, heavier drinkers and those who drink over long periods of time might not be drinking to intoxication, yet could be considered binge drinkers by this definition.

In 2004 the National Institute on Alcohol Abuse and Alcoholism defined a binge as a pattern of drinking associated with producing a blood alcohol concentration (BAC) of at least 80 mg/dl (0.08%).⁹ In addition to the number of drinks consumed, this definition applies gender-specific anthropometric estimates of the drinker's total body water and the duration of the drinking episode in order to determine if the estimated resultant BAC equals or exceeds 0.08%. The BAC of 0.08% was chosen, in part, because of its functional impact on the drinker. 0.08% is the legal limit used to charge drinkers with an impaired driving offense and laboratory studies report reliable behavioral impairments at this BAC.¹³ Compared with the 5/4 definition, the 0.08% definition has greater sufficiency as a statistic because it also considers additional factors, such as the drinker's body weight, gender, and the duration of consumption. To achieve a BAC of 0.08%, the total amount of alcohol must be consumed at a rate sufficient to overcome the rate at which the body eliminates alcohol via metabolic processes. The 0.08% definition has been widely used to characterize drinkers in research studies.¹² However, the definition has been criticized on the grounds that it is too particular and may exclude some at-risk drinkers who do not necessarily achieve BACs of 0.08% because they consume alcohol over prolonged durations each time they drink.⁵

In young adults, heavy episodic drinking is a predictor of escalating alcohol-related problems, including alcohol dependence.^{7,14} Moreover, in recent years rates of binge drinking have increased markedly among female college students, particularly between the ages of 21–23 years.² These findings are of special concern because heavy episodic drinking poses particular behavioral and health risks for women. Thus, it is important to determine the degree to which commonly used definitions of binge drinking actually indicate concomitant alcohol-related problems or the risk of developing these problems in the future. Although several studies have used either the 5/4 or the 0.08% definition of binge drinking, no study to date has compared the two definitions in terms of their agreement with commonly used screening instruments designed to detect at-risk drinking. This was the purpose of the present study.

At-risk, problem drinkers are individuals who report negative consequences as a result of their alcohol use (e.g., social and personal problems), but who generally do not meet criteria for alcohol dependence.¹⁵ The Alcohol Use Disorders Identification Test (AUDIT) is a self-report instrument commonly used to screen for alcohol-related problems. The 10-item instrument assesses drinking patterns and specific problems related to one's alcohol use, such as feelings of guilt, failure to meet responsibilities, physical injuries, and health problems.¹⁶ The AUDIT has demonstrated reliability and validity for identifying at-risk, problem drinkers in several populations, including college students.^{17–20} A tacit assumption underlying current definitions of binge drinking is that such consumption levels are accompanied by alcohol-related problems indicative of an at-risk drinker. However, it is unclear as to the degree to which 5/4 and 0.08% definitions indicate concomitant alcohol-related problems as identified by screening instruments, particularly in college students.

To address this question, the present study compared the validity of each binge definition as an indicator of at-risk, problem drinking. Data were gathered on the drinking habits of 251

college student drinkers. Drinkers were classified as non-binge drinkers or as binge drinkers based on the 5/4 definition or the 0.08% BAC definition. The two definitions of binge drinking were examined in terms of their sensitivity and specificity as indicators of alcohol-related problems as determined by the subjects' scores on the AUDIT. It was predicted that the 5/4 definition would demonstrate high sensitivity as an indicator of alcohol-related problems, but might lack specificity given concerns that the definition could be an overly liberal indicator of heavy, episodic drinking.^{5,12} By contrast, the 0.08% definition was expected to demonstrate high specificity, but possibly less sensitivity because of failures to identify problem drinkers who consume alcohol over prolonged durations and therefore do not achieve BACs of 0.08%. The study also examined gender differences in order to determine if male and female binge drinkers differ in their patterns of alcohol consumption.

Methods

Participants

The study examined 251 college students (143 men and 108 women) who were between the ages of 19 and 34 years ($M = 26.5$, $SD = 4.6$). The sample was comprised of individuals who volunteered to undergo assessments for participation in studies concerning the effects of alcohol on cognitive and behavioral functioning. In terms of racial make-up, subjects identified themselves as Caucasian ($n=221$), African American ($n=15$), Hispanic ($n=7$), Asian American ($n=6$), American Indian ($n=1$), and unreported ($n=1$). All volunteers completed questionnaires that provided demographic information, drug use history, and physical and mental health status. Volunteers had to report recent use of alcohol (i.e., drinking in the past month). Volunteers were also excluded if they reported any psychiatric disorder, head trauma, or other CNS injury. Participants were recruited via notices posted on community bulletin boards and by word of mouth. All volunteers provided informed consent prior to participating. The study was approved by the University of Kentucky Medical Institutional Review Board. Volunteers received \$30 for their participation.

Materials

Alcohol Use Disorders Identification Test (AUDIT).¹⁶—The AUDIT is a screening instrument that was used to classify subjects as at-risk, problem drinkers or non-risk drinkers based on the occurrence and severity of alcohol-related problems. The 10-item, self-report questionnaire covers patterns of drinking, dependence and other negative consequences of drinking over the past year and has a total score range from zero (no alcohol-related problems) to 40 (most severe alcohol-related problems). A score of 8 or greater was used to classify male subjects as at-risk drinkers with alcohol-related problems. A score of 6 or greater classified female subjects as at-risk, problem drinkers. Psychometric studies have reported that the 6+/8+ cut-scores provide the greatest degree of correct classification in most populations, including college-aged drinkers.^{17,18,21}

Personal Drinking Habits Questionnaire (PDHQ).²²—Subjects completed questions concerning their personal drinking habits with instructions emphasizing that they should respond in regard to what was most typical or usual for them. Participants were asked about how often they drank alcohol, what kind of alcoholic beverage they drank, what was the typical quantity of drinks that they drank in a single drinking occasion, and what was the duration of a typical drinking occasion. This questionnaire yielded several measures of the drinker's typical quantity and typical frequency of alcohol use. With respect to quantity, the questionnaire measured the number of standard alcoholic drinks typically consumed per occasion. Standard drinks were defined as a 12 oz bottle of beer at 5% alcohol per volume, a 5 oz glass of wine at 12% alcohol per volume, and a 1.5 oz shot of liquor at 40% per volume. Quantity was also measured as typical dose, expressed in terms of absolute alcohol,

consumed per drinking occasion. The mL of absolute alcohol was determined based on known alcoholic contents of the types of typical drinks reported (beer, wine or spirits). This value was multiplied by the number of drinks reported per typical occasion to obtain a measure of total per occasion quantity of absolute alcohol. This quantity was then corrected for individual differences in body weight by dividing the value by the participant's per kg body weight. The body weight correction provides an estimate of alcohol "dose" that provides useful information about its possible behavioral impact on the individual. In regard to gender differences, men report greater total consumption of alcohol than women, however, once corrected for body weight, gender differences often disappear.^{23,24}

The PDHQ also obtained measures of weekly frequency of alcohol use, hourly duration of a typical drinking occasion, and the drinker's history of alcohol use based on the onset age of regular alcohol use, measured as total months. The psychometrics of the PDHQ are well-documented.^{22,23} The measure provides a reliable and valid assessment of drinking habits in terms of typical quantity, frequency of use, and duration of drinking episode.

Procedure

Eligible volunteers attended an assessment session. Following informed consent, subjects were weighed and completed demographic and medical history questionnaires, the PDHQ and the AUDIT. Participants were classified as binge and non-binge drinkers based on the 5/4 and 0.08% definitions. For the 5/4 definition, subjects were classified as binge drinkers if they reported consuming a typical amount of 5 or more drinks per occasion for a man and 4 or more drinks per occasion for a woman. For the 0.08% definition, PDHQ measures of typical quantity and drinking duration, along with the subject's gender and body weight, were used to estimate the resultant BAC achieved during the typical drinking episode. Participants' self-reported typical number of standard drinks consumed per occasion was converted to milligrams of absolute alcohol based on known alcoholic contents of the type of drink reported (beer, wine or spirits). The estimated resultant BAC was calculated from these variables using well-established, valid anthropometric-based BAC estimation formulae which assume an average clearance rate of 15 mg/dl per hour of the drinking episode.²⁵ These formulae have been used in previous studies and have been shown to yield high correlations with actual resultant BACs obtained under laboratory conditions.²⁶ Based on the estimated resultant BACs, participants were classified as binge drinkers if their resultant BAC was 0.08% or higher and were classified as non-binge drinkers if their resultant BAC was below 0.08%.

Results

At-risk versus Non-risk Drinkers

The mean AUDIT score for the entire sample was 7.8 (SD = 4.7) and the internal consistency measured by Cronbach's Alpha was 0.80. Based on the AUDIT cut-score of 6+/8+, 143 subjects (57%) met criteria for at-risk, problem drinking. Of those at risk, 87 were men and 56 were women. Table 1 presents the drinking habits of the at-risk and non-risk drinkers. As expected, there was evidence of greater quantity and frequency of alcohol use among those classified as at-risk by the AUDIT. Compared with non-risk drinkers, at-risk drinkers consumed a greater quantity of alcohol per occasion, both in terms of number of standard drinks, $t(249) = 11.7, p < .001$, and in terms of alcohol dose based on body weight, $t(249) = 12.2, p < .001$. Accordingly, at-risk drinkers also achieved a higher estimated BAC during a drinking occasion compared with non-risk drinkers, $t(249) = 9.6, p < .001$. Compared with non-risk drinkers, at-risk drinkers also drank more frequently, $t(249) = 10.5, p < .001$, and for a longer hourly duration during a typical drinking episode, $t(249) = 7.5, p < .001$. No group differences were observed in the length of drinking history or in body weight.

Binge Drinking Classifications

Tables 2A, 2B, and 2C present the drinking habits of participants classified as binge drinkers in accordance with the 5/4 definition (Table 2A), the 0.08% definition (Table 2B), and those classified as non-binge drinkers (Table 2C). Of the entire sample, 140 (56%) met at least one of the two definitions of binge drinker. Of those, 111 subjects met the 5/4 definition and 84 individuals met the 0.08% definition. Most of the 0.08% binge drinkers ($n = 82$) also met the 5/4 definition of binge drinker. As expected, binge drinkers obtained higher AUDIT scores compared with non-binge drinkers for both the 5/4 definition, $t(247) = 12.0, p < .001$, and the 0.08% definition, $t(193) = 11.6, p < .001$. On average, binge drinkers drank in excess of 6 drinks per occasion, achieving average estimated BACs in excess of 100 mg/dl (0.10%). By contrast, non-binge drinkers on average consumed less than 3 drinks per occasion, achieving an estimated BAC of less than 30 mg/dl (0.03%).

Tables 2A, 2B, and 2C also present these results separated by gender groups. Women were well represented among the binge drinkers, comprising 41% of those meeting the 5/4 binge drinker (Table 2A) definition and 45% of those meeting the 0.08% definition (Table 2B). For both definitions, female binge drinkers reported consuming significantly fewer drinks per occasion than male binge drinkers ($ps < .001$). However, in terms of typical dose based on body weight, this gender difference was no longer evident, as both female and male binge drinkers reported consuming nearly identical doses per occasion ($ps > .605$). In calculating the estimated BAC achieved during a typical drinking occasion, results showed that female binge drinkers actually achieved significantly higher estimated BACs than male binge drinkers, regardless of binge definition ($ps < .011$). Evidence for greater BACs among women was specific to binge drinkers, as no gender differences in estimated BACs were observed in the non-binge drinkers (Table 2C).

Validity of Binge Drinking Definitions as Indicators of At-Risk Drinking

Table 3 reports on the validity of each binge definition as an indicator of an at-risk, problem drinker defined by the 6+/8+ cut-score on the AUDIT. The 5/4 definition of binge drinking showed high degrees of sensitivity and specificity as an indicator of an at-risk drinker. In terms of sensitivity, 83% of the at-risk drinkers were captured by the 5/4 binge definition. With regard to specificity, 81% of the non-risk drinkers appropriately failed to meet the 5/4 binge definition. By contrast, the 0.08% binge definition showed poor sensitivity as an indicator of at-risk, problem drinking. Only 52% of the at-risk drinkers were captured by the 0.08% binge definition. The 0.08% definition did show high specificity, with 92% of the non-risk drinkers appropriately failing to meet this definition of binge drinker.

In order to examine factors that might account for the comparatively low sensitivity of the 0.08% definition, Table 4 compares the drinking habits of at-risk drinkers who failed to meet the 0.08% binge definition to those at-risk drinkers who met the definition. In terms of typical quantity of alcohol consumption per occasion, at-risk drinkers who failed to meet the 0.08% binge definition consumed significantly less alcohol compared with the at-risk drinkers who met the binge definition, both in terms of standard drinks and per kg dose ($ps < .001$). Similarly, at-risk drinkers who failed to meet the 0.08% definition also achieved a significantly lower BAC during a typical drinking occasion compared with at-risk drinkers who met the 0.08% binge definition ($p < .001$). By contrast, an examination of drinking frequency showed an opposite difference in alcohol consumption between these two groups. At-risk drinkers who failed to meet the 0.08% binge definition reported drinking significantly more frequently compared with those who met the binge definition ($p < .05$). It is also notable that at-risk drinkers failing to meet 0.08% definition weighed more than the at-risk drinkers who met the 0.08% definition ($p < .001$). In sum, these data indicate that a high percentage of at-risk drinkers (48%) were not considered binge drinkers according to

the 0.08% definition, and that these individuals drank lower amounts of alcohol per episode, but also drank more frequently.

Discussion

The present study compared two commonly applied definitions of binge drinking (5/4 and 0.08%) in terms of their ability to indicate alcohol-related problems characteristic of at-risk drinkers as measured by a commonly used screening instrument, the AUDIT. The population studied was college-aged drinkers of whom 56% were classified as at-risk drinkers according to the AUDIT cut-score of 6+/8+. There was also a high prevalence of binge drinking in the sample, with 54% of drinkers meeting the 5/4 definition and 33% meeting the 0.08% definition. In terms of risk indication, the results showed that the 5/4 definition was effective at detecting over 80% of individuals classified as at-risk by the AUDIT. The 5/4 definition also demonstrated high specificity with most non-risk drinkers also failing to meet the definition of a 5/4 binge drinker. By contrast, the 0.08% definition of binge drinking was a poorer indicator of risk. The definition captured fewer at-risk drinkers, failing to identify nearly one-half of these individuals as binge drinkers.

Some important findings emerged when drinking habits were examined in an effort to understand why so many at-risk drinkers (48%) failed to meet the 0.08% definition of binge drinking. The at-risk drinkers who failed to meet the 0.08% definition drank lower amounts of alcohol per episode and achieved a lower estimated BAC compared with at-risk drinkers who met the 0.08% definition. It was also noted that those failing to meet the 0.08% definition were heavier in terms of body weight. For any given number of drinks, a greater body weight would result in a lower estimated BAC during the drinking episode. The 0.08% definition is based on BAC estimates that are influenced by the drinker's body weight. Thus, although these individuals might consume appreciable amounts of alcohol in terms of standard drinks, they might escape identification as binge drinkers because their larger body mass results in lower estimated BACs per drinking occasion. Moreover, it is important to recognize that those who escaped identification as 0.08% binge drinkers because of larger body mass were not necessarily "safe" drinkers as they did meet criteria for at-risk, problem drinkers on the AUDIT. This suggests that drinking to a sub-threshold BAC (i.e., < 0.08%) is not sufficient to avoid alcohol-related problems in this population, and that total quantity (i.e., total standard drinks) per occasion might contribute to risk independent of the drinker's body weight and the BAC achieved during typical drinking episodes.

At-risk drinkers who escaped detection as 0.08% binge drinkers also differed from those identified as 0.08% binge drinkers in another important way that involved drinking frequency. Specifically, at-risk drinkers who did not meet the 0.08% definition drank more frequently than their at-risk counterparts who did meet the definition. Frequency of drinking episodes contributes to the identification of at-risk drinking by the AUDIT. Indeed, two items from the AUDIT specifically inquire about frequency of any drinking and frequency of heavy drinking. Quantity and frequency measures assess dissociable aspects of drinking habits that relate to different patterns of alcohol abuse that lead to alcohol-related problems.²⁷ For example, frequency measures can be indicative of drinking patterns motivated by physiological dependence, whereas measures of quantity might better assess loss of control problems that are indicative of heavy episodic drinking.^{28,29} Indeed, evidence that the young adults in the current study can be identified as at-risk drinkers without meeting the criteria as binge drinkers, highlights the importance of considering frequency of consumption in determining risky drinking versus relying solely on measures of quantities per occasion, as is commonly emphasized by the binge drinking concept in general.

The high prevalence of binge drinkers identified in this population (> 50%) supports previous reports on the high occurrence of binge drinking among college campuses across the United States.² The present study also found that women accounted for a large percentage of the binge drinkers, regardless of how binge drinking was defined. The finding supports survey studies showing that rates of binge drinking increase markedly among female college students, particularly between the ages of 21–23 years.^{2,30,31} The results of the current study showed that female binge drinkers actually achieved significantly higher estimated BACs per episode than their male binge drinking counterparts. These findings are important because heavy episodic drinking poses particular behavioral and health risks for women. Acute dose-challenge studies show that women tend to achieve higher BACs from a dose of alcohol than men. This BAC difference is attributed to gender differences in body water volume, alcohol dehydrogenase levels, and other factors.^{25,32,33} Women also appear more sensitive to the behaviorally-impairing effects of alcohol than their male counterparts. Reviews of studies on the acute behavioral effects of alcohol find that women tend to display more intense behavioral impairments than men at comparable BACs on a wide range of cognitive and behavioral tasks, including simulated driving.^{34–36} Finally, with respect to health consequences, it has become well-known that women incur greater physiological risk of organ damage (e.g., liver cirrhosis) than do men with comparable histories of alcohol use.³⁷ In light of evidence for women's increased vulnerability to the adverse effects of alcohol, findings that young women might actually drink to achieve higher BACs than their male counterparts raises serious concerns about the health and behavioral risks incurred by this group of young heavy episodic drinkers.

Although the study identifies important differences in the degree to which common definitions of binge drinking actually indicate at-risk, problem drinking, it is also important to recognize some potential limitations of the findings. First, it should be recognized that the AUDIT is a screening instrument for potential alcohol abuse and is not used in the diagnosis of alcohol use disorders that requires clinical interviews and medical evaluations. However, the purpose of the present study was to examine the corroboration of binge drinking definitions with a commonly used screening instrument based on symptoms of abuse and not determined solely by consumption levels as is the case for at-risk indicators based on binge drinking criteria. It is also recognized that the AUDIT score is, in part, determined by levels of typical quantity of alcohol consumed per occasion (Items 2 and 3). Therefore, some differences in AUDIT scores between binge drinkers and non-bingers could simply reflect overlapping criteria. However, supplemental analyses of AUDIT scores with the two quantity items removed also confirmed that binge drinkers, according to either definition, achieved significantly higher AUDIT scores than non-bingers ($p < .001$). Thus, compared with non-bingers, the binge drinkers in our study reported greater alcohol-related problems on the AUDIT based on symptoms other than those concerning excessive quantity of consumption.

In conclusion, the present study highlights some specific advantages of defining binge drinking in terms of standard drinks per occasion over estimating the BAC achieved by the drinker. However, it is also important to consider some practical implications of these definitions in general. The study used the AUDIT as the criterion measure of at-risk, problem drinking. Indeed, there is considerable evidence for the validity of the AUDIT as a measure of at-risk drinking in this and in other populations.¹⁷ Given the AUDIT's utility in this regard, one might question the need to use any definition of binge drinking as an indicator of alcohol-related problems, and instead simply rely on instruments, such as the AUDIT. However, among clinicians and health-care professionals there remains limited acceptance and application of screening instruments for alcohol-related problems.³⁸ Rather, intake screens for alcohol-related problems and dependence often are based on self-reports of typical quantities of alcohol consumed per episode. Furthermore, in terms of

practicability, the ease of reporting “typical quantity” in terms of number of standard drinks is a major advantage of the 5/4 definition over the 0.08% definition of binge drinking. Clinicians and health-care professionals typically lack the knowledge and time to transform typical quantity measures into estimates of resultant BACs based on calculations involving body mass, gender, rates of metabolism, and so on. Finally, it should be noted that any assessment of at-risk, problem drinking should also consider frequency of consumption as an indicator of other alcohol-related problems (e.g., physical dependence) that are not necessarily evident from the quantity-based assessments so commonly emphasized by the binge drinking concept.

Acknowledgments

This work was supported by grants R01 AA12895 and R01 AA018274 from the National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD and by grant R21 DA021027 from the National Institute on Drug Abuse, Bethesda, MD (Dr. Fillmore).

References

1. Nelson TF, Xuan Z, Lee H, Weitzman ER, Wechsler H. Persistence of heavy drinking and ensuing consequences at heavy drinking colleges. *J Stud Alcohol Drugs*. 2009; 70:726–734. [PubMed: 19737497]
2. Grucza RA, Norberg KE, Bierut LJ. Binge drinking among youths and young adults in the United States: 1979–2006. *J Am Acad Child Adolesc Psychiatry*. 2009; 48:692–702. [PubMed: 19465879]
3. Hingson R, Heeren T, Winter M, Wechsler H. Magnitude of alcohol-related mortality/morbidity among US college students ages 18–24: Changes from 1998–2001. *Annu Rev Public Health*. 2005; 26:259–279. [PubMed: 15760289]
4. Robin RW, Long JC, Ramussen JK, Albaugh B, Goldman D. Relationship of binge drinking to alcohol dependence, other psychiatric disorders, and behavioral problems in an American Indian tribe. *Alcohol Clin Exp Res*. 1988; 22:518–523. [PubMed: 9581662]
5. Courtney KE, Polich J. Binge drinking in young adults: Data, definitions, and determinants. *Psychol Bull*. 2009; 135:142–156. [PubMed: 19210057]
6. Jellinek EM. Phases of alcohol addiction. *Q J Stud Alcohol*. 1952; 13:673–684. [PubMed: 13014274]
7. Wechsler H, Nelson TF. Binge drinking and the American college students: What’s five drinks? *Psychol Addict Behav*. 2001; 15:287–291. [PubMed: 11767258]
8. Goldman MS. Commentary on White, Kraus, and Swartzwelder: “Many college freshmen drink at levels far beyond the binge threshold”. *Alcohol Clin Exp Res*. 2006; 30:919–921. [PubMed: 16737448]
9. NIAAA. NIAAA Newsletter. Vol. 3. Washington, DC: NIAAA; Winter. 2004 NIAAA council approves definition of binge drinking.
10. Perkins HW, DeJong W, Linkenbach J. Estimated blood alcohol levels reached by “binge” and “nonbinge” drinkers: A survey of young adults in Montana. *Psychol Addict Behav*. 2001; 15:317–320. [PubMed: 11767263]
11. White HR, McMorris BJ, Catalano RF, Fleming CB, Haggerty KP, Abbott RD. Increases in alcohol and marijuana use during the transition out of high school into emerging adulthood: The effects of leaving home, going to college, and high school protective factors. *J Stud Alcohol*. 2006; 67:810–822. [PubMed: 17060997]
12. Lange JE, Voas RB. Defining binge drinking quantities through resulting blood alcohol concentrations. *Psychol Addict Behav*. 2001; 15:310–316. [PubMed: 11767262]
13. Fillmore MT. Acute alcohol-induced impairment of cognitive functions: past and present findings. *Int J Disabil Hum Dev*. 2007; 6:115–125.
14. Enoch MA, Goldman D. Problem drinking and alcoholism: diagnosis and treatment. *Am Fam Physician*. 2002; 65:441–448. [PubMed: 11858627]

15. Schmidt A, Barry KL, Fleming MF. Detection of problem drinkers: the alcohol use disorders identification test (AUDIT). *South Med J*. 1995; 88:52–59. [PubMed: 7817228]
16. Babor TF, Kranzler HR, Lauerma RJ. Early detection of harmful alcohol consumption: comparison of clinical, laboratory, and self-report screening procedures. *Addict Behav*. 1989; 14:139–157. [PubMed: 2728952]
17. Berner MM, Kriston L, Bentele M, Härter M. The alcohol use disorders identification test for detecting at-risk drinking: A systematic review and meta-analysis. *J Stud Alcohol Drugs*. 2007; 68:461–473. [PubMed: 17446987]
18. Kokotailo PK, Egan J, Gangnon R, Brown D, Mundt M, Fleming M. Validity of the alcohol use disorders identification test in college students. *Alcohol Clin Exp Res*. 2004; 28:914–920. [PubMed: 15201634]
19. McCann BS, Simpson TL, Ries R, Roy-Byrne P. Reliability and validity of screening instruments for drug and alcohol abuse in adult seeking evaluation for Attention-Deficit/Hyperactivity Disorder. *Am J Addict*. 2000; 9:1–9. [PubMed: 10914288]
20. Selin KH. Test-Retest Reliability of the Alcohol Use Disorder Identification Test in a General Population Sample. *Alcohol Clin Exp Res*. 2003; 27:1428–1435. [PubMed: 14506403]
21. Reinart DF, Allen JP. The Alcohol Use Disorders Identification Test (AUDIT): a review of recent research. *Alcohol Clin Exp Res*. 2002; 26:272–279. [PubMed: 11964568]
22. Vogel-Sprott, M. Alcohol tolerance and social drinking: Learning the consequences. New York: Guilford Press; 1992.
23. Vogel-Sprott M. Response measures of social drinking: Research implications and applications. *J Stud Alcohol*. 1983; 44:817–836. [PubMed: 6645543]
24. York JL, Welte JW. Gender comparisons of alcohol consumption in alcoholic and nonalcoholic populations. *J Stud Alcohol*. 1994; 55:743–750. [PubMed: 7861804]
25. Watson PE, Watson ID, Batt RD. Prediction of blood alcohol concentrations in human subjects: Updating the Widmark Equation. *J Stud Alcohol*. 1981; 42:547–556. [PubMed: 7289599]
26. Fillmore MT. Cognitive preoccupation with alcohol and binge drinking in college students: Alcohol-induced priming of the motivation to drink. *Psychol Addict Behav*. 2001; 15:325–332. [PubMed: 11767265]
27. Midanik LT, Tam TW, Greenfield TK, Caetano R. Risk functions for alcohol-related problems in a 1988 US national sample. *Addiction*. 1996; 91:1427–1456. [PubMed: 8917925]
28. Dawson DA. Consumption indicators of alcohol dependence. *Addiction*. 1994; 89:345–350. [PubMed: 8173504]
29. Wechsler H, Isaac B. 'Binge' drinkers at Massachusetts colleges. Prevalence, drinking style, time trends, and associated problems. *JAMA*. 1997; 267:2929–2931. [PubMed: 1583763]
30. Plant ML. The role of alcohol in women's lives: A review of issues and responses. *J Subst Use*. 2008; 13:155–191.
31. Wechsler H, Lee JE, Kuo M, Seibring M, Nelson TF, Lee H. Trends in college binge drinking during a period of increased prevention efforts. *J Am Coll Health*. 2002; 50:203–218. [PubMed: 11990979]
32. Frezza M, di Padova C, Pozzato G, Terpin M, Baraona E, Lieber C. High blood alcohol levels in women. The role of decreased gastric alcohol dehydrogenase activity and first-pass metabolism. *N Engl J Med*. 1990; 322:95–99. [PubMed: 2248624]
33. Whitfield JB, Zhu G, Duffy DL, et al. Variation in alcohol pharmacokinetics as a risk factor for alcohol dependence. *Alcohol Clin Exp Res*. 2001; 25:1257–1263. [PubMed: 11584143]
34. Miller MA, Weafer J, Fillmore MT. Gender differences in alcohol impairment of simulated driving performance and driving related skills. *Alcohol Alcohol*. 2009; 44:586–593. [PubMed: 19786725]
35. Mumenthaler MS, Taylor JL, O'Hara R, Yesavage JA. Gender differences in moderate drinking effects. *Alcohol Res Health*. 1999; 23:55–64. [PubMed: 10890798]
36. Witt ED. Puberty, hormones, and sex differences in alcohol abuse and dependence. *Neurotoxicol Teratol*. 2007; 29:81–95. [PubMed: 17174531]

37. Hall, P. Factors influencing individual susceptibility to alcoholic liver disease. In: Hall, P., editor. *Alcoholic Liver Disease: Pathology and Pathogenesis*. 2. London: Edward Arnold Press; 1995. p. 299-316.
38. Webster-Harrison PJ, Barton AG, Barton SM, Anderson SD. General practitioners' and practice nurses' knowledge of how much patients should and do drink. *Br J Gen Pract*. 2001; 51:218–220. [PubMed: 11255903]

Table 1

Mean (SD) drinking habit measures, AUDIT Score, and estimated BAC for At-Risk and Non-Risk Drinkers.

	At-Risk Drinkers (n=143)	Non-Risk Drinkers (n=108)	Significance
AUDIT	10.9 (3.8)	3.8 (2.1)	**
Drinks	6.0 (2.2)	3.0 (1.7)	**
Dose	1.4 (0.5)	0.7 (0.4)	**
BAC	94.3 (56.8)	35.4 (32.3)	**
Duration	4.2 (1.3)	2.9 (1.5)	**
Frequency	2.5 (1.3)	1.0 (0.8)	**
History	66.9 (26.8)	65.7 (42.6)	ns
Body Weight	74.1 (14.5)	77.0 (17.8)	ns

AUDIT: total score. Drinks: number of standard drinks; Dose: milliliters of absolute alcohol per kilogram of body weight; BAC: calculated blood alcohol concentration mg/dl; Duration: length, in hours, of a drinking occasion; Frequency: number of drinking occasions per week; History: period since onset of regular alcohol use in months; Body weight in kg. At-risk status determined by AUDIT cut-scores of 8+/6+ (men/women). Group differences based on independent samples *t* tests

*
 $p < 0.05$,

**
 $p < 0.01$, ns=nonsignificant.

Table 2A

Drinking habits of men and women classified as 5/4 binge drinkers.

	Total (n=138)	Men (n=81)	Women (n=57)	Gender Difference
AUDIT	10.4 (4.2)	11.3 (4.0)	9.1 (4.2)	**
Drinks	6.4 (1.9)	7.2 (1.9)	5.4 (1.4)	**
Dose	1.5 (0.4)	1.5 (0.4)	1.5 (0.5)	ns
Duration	4.3 (1.2)	4.4 (1.2)	4.2 (1.2)	ns
Frequency	2.2 (1.2)	2.3 (1.2)	2.1 (1.1)	ns
BAC	103.2 (51.9)	93.9 (44.8)	116.5 (58.5)	*
History	65.3 (29.7)	62.7 (25.0)	69.0 (35.2)	ns
Body weight	74.3 (15.0)	82.0 (11.9)	63.4 (11.9)	**

AUDIT: total score. Drinks: number of standard drinks; Dose: milliliters of absolute alcohol per kilogram of body weight; BAC: calculated blood alcohol concentration mg/dl; Duration: length, in hours, of a drinking occasion; Frequency: number of drinking occasions per week; History: period since onset of regular alcohol use in months; Body weight in kg. Group differences based on independent samples *t* tests

* $p < 0.05$,

** $p < 0.01$, ns=nonsignificant.

Table 2B

Drinking habits of men and women classified as 0.08% binge drinkers.

	Total (n=84)	Men (n=46)	Women (n=38)	Gender Difference
AUDIT	11.2 (4.7)	12.1 (4.7)	10.0 (4.5)	*
Drinks	7.1 (2.0)	8.0 (2.0)	5.9 (1.4)	**
Dose	1.7 (0.4)	1.8 (0.4)	1.7 (0.4)	ns
Duration	4.0 (1.0)	4.0 (1.0)	4.0 (1.1)	ns
Frequency	2.1 (1.1)	2.1 (1.2)	2.2 (1.0)	ns
BAC	134.8 (40.7)	124.5 (33.6)	147.2 (45.2)	*
History	59.7 (23.8)	59.0 (25.4)	60.7 (21.9)	ns
Body weight	69.1 (12.9)	77.3 (9.3)	59.2 (9.2)	**

AUDIT: total score. Drinks: number of standard drinks; Dose: milliliters of absolute alcohol per kilogram of body weight; BAC: calculated blood alcohol concentration mg/dl; Duration: length, in hours, of a drinking occasion; Frequency: number of drinking occasions per week; History: period since onset of regular alcohol use in months; Body weight in kg. Group differences based on independent samples *t* tests

*
 $p < 0.05$,

**
 $p < 0.01$, ns=nonsignificant.

Table 2C

Drinking habits of men and women classified as non-binge drinkers.

	Total (n=111)	Men (n=60)	Women (n=51)	Gender Difference
AUDIT	4.6 (3.1)	5.5 (3.5)	3.6 (2.3)	**
Drinks	2.5 (1.0)	2.8 (1.0)	2.2 (0.8)	**
Dose	0.6 (0.3)	0.6 (0.2)	0.6 (0.4)	ns
Duration	2.8 (1.5)	2.8 (1.5)	2.9 (1.5)	ns
Frequency	1.4 (1.3)	1.7 (1.6)	1.1 (0.9)	*
BAC	26.1 (20.7)	25.0 (21.1)	27.3 (20.4)	ns
History	68.0 (39.7)	68.0 (44.2)	67.9 (34.2)	ns
Body weight	76.9 (17.2)	83.6 (17.6)	68.9 (12.7)	**

AUDIT: total score. Drinks: number of standard drinks; Dose: milliliters of absolute alcohol per kilogram of body weight; BAC: calculated blood alcohol concentration mg/dl; Duration: length, in hours, of a drinking occasion; Frequency: number of drinking occasions per week; History: period since onset of regular alcohol use in months; Body weight in kg. Group differences based on independent samples *t* tests

* $p < 0.05$,

** $p < 0.01$, ns=nonsignificant.

Table 3

Sensitivity and specificity of binge drinking definitions as indicators of at-risk drinking as measured by the AUDIT.

	5/4 Binge Drinkers	0.08% Binge Drinkers
Sensitivity	0.83	0.52
Specificity	0.81	0.92

Table 4

Drinking habits of 143 at-risk drinkers based on the AUDIT subgrouped according to who met the definition of a 0.08% binge drinker and those who did not meet 0.08% definition.

	<u>Met 0.08% Binge Definition</u>		Significance
	Yes (n= 75)	No (n=68)	
AUDIT score	11.9 (4.5)	9.8 (2.5)	**
Drinks	7.2 (2.0)	4.6 (1.5)	**
Dose	1.8 (0.4)	1.0 (0.3)	**
BAC	137.5 (41.0)	46.6 (24.3)	**
Duration	4.1 (1.0)	4.3 (1.5)	ns
Frequency	2.3 (1.1)	2.7 (1.4)	*
History	60.8 (22.3)	73.6 (29.7)	**
Body Weight	69.2 (12.6)	79.5 (14.6)	**

AUDIT: total score. Drinks: number of standard drinks; Dose: milliliters of absolute alcohol per kilogram of body weight; BAC: calculated blood alcohol concentration mg/dl; Duration: length, in hours, of a drinking occasion; Frequency: number of drinking occasions per week; History: period since onset of regular alcohol use in months; Body weight in kg. Group differences based on independent samples *t* tests

*
 $p < 0.05$,

**
 $p < 0.01$, ns=nonsignificant.