High-Intensity Drinking

Megan E. Patrick and Beth Azar

Megan E. Patrick, Ph.D., is a research associate professor at the University of Michigan Institute for Social Research, Ann Arbor, Michigan.

Beth Azar, M.A., is a science writer for Alcohol Research: Current Reviews.

Binge drinking thresholds have long been set at four or more drinks for women and five or more drinks for men over the course of a few hours. However, a significant number of people regularly consume much higher amounts of alcohol: double or even triple the standard binge drinking threshold. Researchers have begun to distinguish between typical binge drinking and this kind of "high-intensity drinking," which is common among certain types of binge drinkers and is often associated with special occasions, including holidays, sporting events, and, notably, 21st birthdays. To understand the social and physical influences of alcohol consumption, it is important for researchers to set standard definitions for high-intensity drinking and distinguish it from other types of alcohol use.

Key words: Alcohol consumption; binge drinking; college drinking; drinking occasions; drinking patterns; heavy drinking; high-intensity drinking

Consuming alcohol until drunk by guzzling beers, slamming shots, and taking swigs from bottles of booze is common fare in movies and on television, which often portray people drinking to extremes. One study, published in the *British Medical Journal*, calculated that James Bond, of book and movie fame, drank about 45 drinks a week.[1] In the 2006 movie *Casino Royale*, Bond slugged down a stunning 20 drinks just before a high-speed car chase that left him in the hospital for 2 weeks. Researchers typically define binge drinking as four or more drinks in a sitting for women and five or more for men (4+/5+). Due to evidence that some people, like the fictitious Bond, drink far above that cutoff, researchers have begun distinguishing between typical binge drinking and this kind of "high-intensity drinking." They have developed new definitions and have begun examining the special challenges of measuring high-intensity drinking, the frequency with which it occurs, when it is most likely to occur and in which populations, and the consequences of this kind of drinking to the drinker and to the community. This article summarizes the most recent research on high-intensity drinking.

Defining High-Intensity Drinking

In the early 1990s, the College Alcohol Study first applied the term "binge drinking" to the pattern of drinking 4+/5+ drinks in a row during the past 2 weeks.[2] Drinking to this extent became a commonly used measure of increased risk of alcohol-related problems. In 2004, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) evaluated and approved defining binge drinking as 4+/5+ drinks in about 2 hours, because it typically leads to a blood alcohol concentration (BAC) of .08 g/dL, the legal cutoff for driving in the United States.[3] One advantage of the definition has been its use in many studies, making results comparable. However, this definition does not distinguish between drinking levels at or just above this binge threshold and those that far exceed it. It also assigns the same level of risk to everyone who crosses the threshold, regardless of how far beyond it they go.[4] And it does not account for differences in metabolism related to body mass, age, and other factors.[5,6] In fact, Pearson and colleagues[7] point out that average-weight women (about 163 lbs.) and men (about 190 lbs.)[8] in the United States would not reach legal intoxication after consuming 4/5 drinks in 2 hours.

Meanwhile, research indicates that a substantial portion of binge drinkers often drink at levels two or three times the 4+/5+ binge threshold, suggesting the need for another term and clear definition for this heavier binge drinking.[9] Although some articles have used the term "extreme binge drinking,"[10] the field is moving toward the term "high-intensity drinking" as the most accurate way to talk about this level of alcohol use.[11]

There is no firm consensus on exactly how many drinks qualify as high-intensity drinking. However, researchers working in this relatively new area have coalesced around the concept of at least twice the typical binge drinking threshold (i.e., 10+ drinks)[10] or twice the gender-specific binge threshold (i.e., 8+ for women/10+ for men).[9,12] Even using a more conservative measure of just two more

drinks over the typical binge drinking cutoff (6+/7+ drinks), Read and colleagues found significant differences when comparing what they called "heavy binge drinkers" with typical binge drinkers.[13] Specifically, heavy binge drinkers typically got drunker than those closer to the standard binge cutoff; when comparing both binge drinking groups with drinkers who did not binge drink, only heavy binge drinkers differed significantly. In this study, compared with drinkers in either of the other categories, heavy binge drinkers reported, on average, three additional unique types of consequences in the previous year, including impaired control, risk behaviors, academic or occupational consequences, and physical dependence.

How Common Is High-Intensity Drinking?

To date, only a handful of binge-drinking studies distinguish levels of use above binge drinking at the 4+/5+ rate. But those that do, find that a significant percentage of teens and young adults engage in high-intensity drinking at levels that far exceed that cutoff. For example, according to studies reporting on data from the national Monitoring the Future (MTF) survey of high school students and young adults, approximately 10% of U.S. 12th-grade high school students and U.S. 19- and 20-year-olds reported consuming 10 or more drinks in a row at least once in the previous 2 weeks, and an additional 4% to 5% reported consuming 15 or more drinks in a row.[10,14] Those rates are even higher among college students. Patrick and Terry-McElrath reported that 19- to 20-year-olds who attended 4-year colleges and did not live with their parents were significantly more likely to engage in high-intensity binge drinking than other young adults: 12.4% of college students consumed 10+ drinks, and 5.1% consumed 15+ drinks, compared with 9% and 3.5% of 19- to 20-year-olds not attending college (see Figure 1).[14]

In a separate study using MTF data to examine the developmental course of high-intensity drinking, Patrick and colleagues found that high-intensity drinking peaks around age 21, and that the peak tends to be highest for young adults who attend college.[15] Another study found that, among a

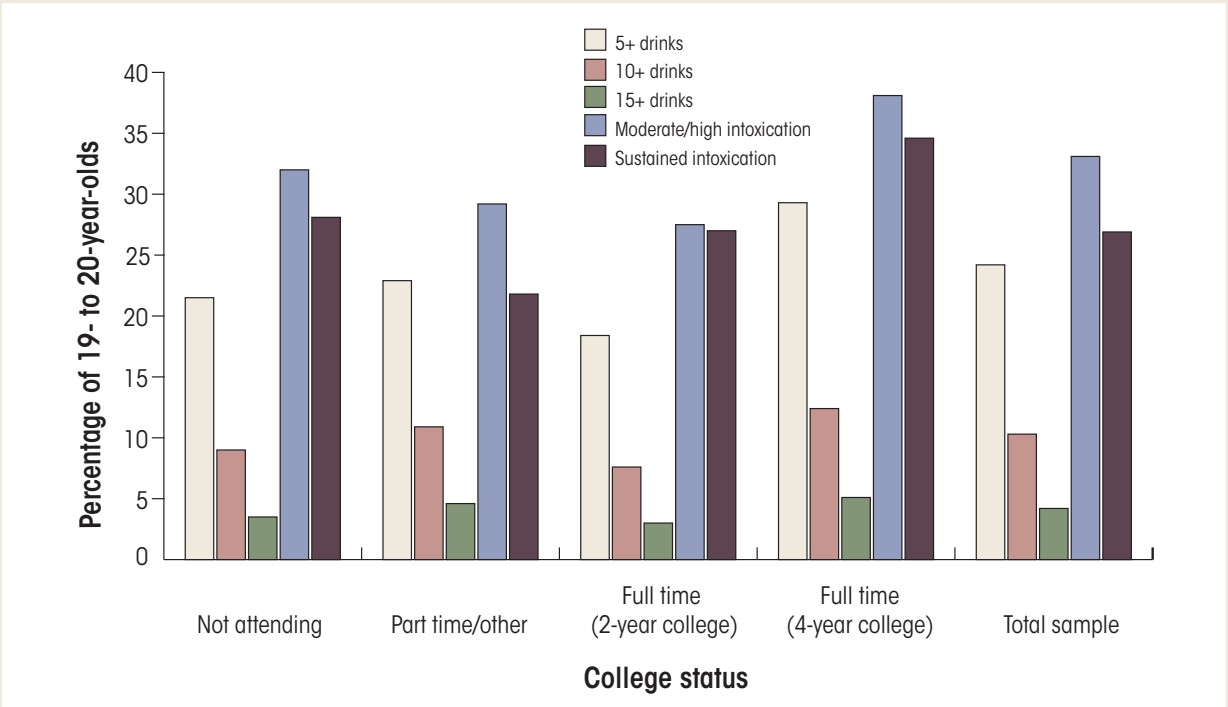

Figure 1 College versus noncollege high-intensity drinking patterns. Young adults who attend a 4-year college full time are more likely to report engaging in high-intensity drinking and binge drinking during the previous 2 weeks than drinkers who do not attend college, attend a 2-year college, or attend college part time. Full-time students at 4-year colleges are also more likely to say that they usually attain moderate/high and sustained intoxication when they drink. *Source:* Figure adapted from Table 1 and Table 3 in Patrick ME, Terry-McElrath YM. High-intensity drinking by underage young adults in the United States. *Addiction.* 2017;112(1):82-93.

sample of 10,424 college freshmen at 14 schools, roughly 20% of males reported consuming 10 or more drinks, and 10% of females reported consuming 8 or more drinks at least once in the 2 weeks preceding the survey.[9] Using the gender-specific high-intensity drinking cutoff of 8+/10+, Patrick and colleagues found that, among a group of 342 college students followed during four 2-week periods over the course of a school year, 67% reported high-intensity drinking on at least one day, and 16.1% of 5,467 drinking days recorded were high-intensity drinking days.[12] These high-intensity drinking days were associated with negative consequences, such as injury, unplanned sex, and aggression.

In addition, Wave 2 data from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) reported that 13% of 18- to 20-year-olds drank 15 or more drinks at some point in the previous year, and 3% did so every 2 weeks.[16] Among the 3,718 young adults followed in the MTF analysis by Patrick and colleagues, those who engaged in high-intensity drinking not only drank more per occasion than typical binge drinkers, but they more often engaged in all levels of binge and high-intensity drinking than those who only reported binge drinking.[15]

Although high-intensity drinking appears to peak in the early 20s, it does not disappear. Terry-McElrath and Patrick recently reported that 12.4% of young adults ages 25 and 26 reported drinking 10 or more drinks in a row at least once in the previous 2 weeks.[17] This type of high-risk drinking was most common in people who were male, white, unmarried, employed, nonparents, and who were alcohol users during high school.

Among people who report binge drinking, consuming well in excess of the five-drink threshold is the norm. Naimi and colleagues examined data from the 14,143 adult binge drinkers who responded to the 2003–2004 binge drinking module of the nationally conducted Behavioral Risk Factor Surveillance System.[18] During their most recent binge drinking episode, 70% of respondents said they consumed 6 or more drinks, 38.4% consumed 8 or more drinks, and 16.9% consumed 11 or more drinks. Highest consumption was for respondents ages 18 to 24, who reported drinking an average of 9.5 drinks during a binge drinking episode. Average amounts for ages 25 to 34, 35 to 44, 45 to 54, and 55 and older were 8.0, 7.4, 7.4, and 6.7, respectively.

What constitutes high-intensity drinking may depend on who is drinking. It is largely established that the binge threshold for women should be lower than for men, because women become more intoxicated than men when consuming the same amount of alcohol (even when they weigh the same). Research also suggests that alcohol affects adolescents and young adults differently from adults. The brain undergoes significant growth and change well into young adulthood. Due to developing brain function, adolescents may be less sensitive to alcohol's behavioral effects, such as a staggering walk or sedation. At the same time, teens may be more receptive to the social-interaction effects of alcohol, including feeling more social and having more fun with friends.[6] In addition, adolescents have been shown to reach a BAC of .08 with fewer drinks.[19] Studies in animals and humans suggest that binge doses of alcohol have more severe and potentially permanent effects on adolescent brains and can more readily lead to addiction.[20,21] As for older adults, studies suggest that people over age 60 metabolize alcohol more slowly and are at higher risk of alcohol-related health problems.[22] Although most studies use the standard 4+/5+ definition of binge drinking for all ages, this evidence suggests that such a threshold may more accurately represent high-intensity drinking among older adults. Indeed, some organizations have begun to recommend that binge drinking thresholds be lowered for older adults. A consensus panel created by the Center for Substance Abuse Treatment defines binge drinking for older adults as four or more drinks per occasion for both women and men.[23] If that is indeed the case, high-intensity drinking may be more common among older adults than is currently reported. Parikh and colleagues calculated that almost 10% of a group of 4,815 participants age 65 and older reported drinking above the 4+/5+ threshold over the previous 30 days.[22] To tease apart the rates of high-intensity drinking, it will be critical for studies to use agreed-upon age-group thresholds for binge drinking and high-intensity drinking.

Ritualized High-Intensity Drinking

Many studies find that people intensify their drinking to celebrate special occasions and to bond with friends during holidays. As with much of the binge-drinking research, most of the studies examining when people are most likely to engage in high-intensity drinking revolves around college students. In a study examining the drinking patterns across the seasons among 462 university students, Schuckit and colleagues found that maximum drinks per occasion increased 18% around the time of a popular 1-day campus spring festival, decreased 29% over the summer, and increased another 31% as school resumed in the fall, suggesting that alcohol consumption by college students is highly influenced by annual rhythms and social context.[24] Expanding beyond college students, Bellis and colleagues found that estimates of average weekly drinking among all drinkers in England increased by nearly a quarter—from 13.6 to 17.1 units per person per week—when they included survey questions on special occasion consumption.[25]

Indeed, research finds that there are occasions when high-intensity drinking is much more likely. Not surprisingly, on and off college campuses, drinking tends to peak on Fridays and Saturdays and is particularly high on

holidays such as the Fourth of July and New Year's Eve.[26-29] Research on event-specific drinking has indicated particularly high quantities of alcohol consumed surrounding collegiate sporting events,[30,31] spring break,[32-34] and to celebrate 21st birthdays (at least in the United States).[35,36]

Holidays

Predictably, people tend to drink more on certain holidays. However, increases in high-intensity drinking may depend on the holiday in question. For example, within a sample of 576 young adults ages 18 and 19, both in college and not, Goldman and colleagues demonstrated that on family-oriented holidays such as Thanksgiving and Christmas, the number of young people who consumed alcohol increased but the average number of drinks consumed per person (counting only those who drank) actually decreased.[27] In contrast, on holiday weeks that included a Halloween-like holiday, New Year's Eve, and the Fourth of July, the average number of drinks consumed per drinker increased significantly compared with nonholiday weeks. Because the researchers measured drinks per week, they could not estimate rates of daily high-intensity drinking. However, another study of 1,124 college students found that, compared with a typical nonholiday weekend, more students consumed alcohol and reached higher BACs on their 21st birthdays, New Year's Eve, New Year's Day, the Fourth of July, spring break, and graduation.[29]

As these data suggest, there is some evidence that, at least for young adults, high-risk drinking is more likely during holidays that are centered on friends as opposed to family. Lefkowitz and colleagues examined drinking during a student-created holiday and found that more students drank, and students drank significantly more than they did on several typical weekend days: 51% of students consumed alcohol compared with 29% on a typical weekend, and students consumed an average of 8.2 drinks compared with a more typical 5.3 drinks.[37]

Sporting Events

Sporting events are also associated with particularly heavy drinking. One study found that men, though not women, drink more on Super Bowl Sunday than on a typical Saturday.[38] And among college football fans, particularly men, drinking on days of high-profile football games is as heavy as alcohol consumption on other well-known drinking days, including New Year's Eve and Halloween weekend.[31] In another study, Merlo and colleagues found high rates of heavy drinking, measured as a BAC of .08 or higher, among 466 tailgaters prior to football games at two large universities: 40.2% of tailgaters at one school and 31.9% at the other.[39] In general, studies find that athletes as well as sports fans are more likely than nonathletes and non–sports fans to engage in binge and high-intensity drinking and to have a heavy-drinking style.[30,40,41]

21st Birthdays

In the United States, according to a number of studies, the day young adults become old enough to drink legally is a day they often take very high risks with their drinking. In fact, more than 80% of study participants drink on their 21st birthdays,[35,36] and many drink far more than typical binge drinking. In a survey of 2,518 college students, for example, Rutledge and colleagues reported that 4 out of 5 study participants drank alcohol to celebrate, drinking an average of 12.6 drinks.[36] Moreover, 12% of male and female birthday drinkers reported consuming 21 drinks, and an additional 22% of men and 12% of women reported that they drank more than 21 drinks. An estimate of blood alcohol content (eBAC) suggested that well more than half of birthday drinkers drank enough to raise their BAC to dangerous levels. Specifically, 68% of female and 79% of male birthday drinkers reached the legal limit of .08 or higher; 35% of female and 49% of male birthday drinkers drank enough to have eBACs of 0.26 or higher (a level associated with potentially serious medical outcomes). Another study suggests that birthday drinking is not without consequences.[42] In Ontario, Canada, where the legal drinking age is 19, hospital admissions data for everyone ages 12 to 30 showed that alcohol-related hospital admissions more than doubled during a person's 19th-birthday week, compared with other times during the year.

At least among college students, where most of the research on 21st birthdays takes place, the heaviest drinking is associated with several factors, including overestimating how much one's peers drink during 21st-birthday celebrations, drinking shots, playing drinking games, celebrating with influential peers, and engaging in 21st-birthday traditions such as free drinks at bars.[43,44]

Spring Break

College student spring break is a highly anticipated time of the year when some college students intend to drink excessively. Studies find that college students who travel with friends dramatically increase their alcohol use and face more alcohol-related consequences, but those who stay home or vacation with their parents tend to drink moderately or not at all.[32,33,45] For students who do drink during spring break, their drinking is positively associated with alcohol-related consequences, including having a hangover, vomiting, and being injured as a result of drinking.[34] And, as with the risk of binge drinking, alcohol-related consequences are more likely if students travel: 32% of travelers and 22% of nontravelers reported having a hangover, 23% of travelers and 15% of nontravelers reported being sick to their stomach or vomiting, and 7.5% of travelers and 4% of nontravelers

reported being injured as a result of drinking.[34]

In a longitudinal study of 651 freshmen undergraduate students, Patrick and colleagues confirmed the findings that binge drinking and negative consequences of drinking are common during spring break.[46] They also discovered that previous drinking behavior was among the strongest predictors of alcohol consumption during spring break. In addition, students were more likely to get drunk and experience negative consequences of drinking if, before spring break, they and their friends agreed they would get drunk. And although students going on trips with friends were more likely to have these kinds of understandings, even students who did not go on trips had understandings with their friends about drinking. These findings suggest that the relative freedom of spring break provides many students with the opportunity to experiment with alcohol use. Litt and colleagues also found that whether or not students were willing to engage in high-risk drinking during spring break—drinking enough to black out or pass out—predicted whether they followed through.[47]

Consequences of High-Intensity Drinking

High-intensity drinking is of particular concern because of the adverse consequences associated with it. These consequences include alcohol-related injuries, alcohol poisoning, risky sexual behavior, vomiting, passing out, blacking out, and long-term harm to academic or occupational status. Although this article focuses on alcohol's short-term consequences, some studies have begun to show long-term effects of binge drinking. For example, longitudinal MTF data links binge drinking at age 18 to higher incidence of alcohol abuse disorder at age 35.[46,48]

One study with a cohort of 15,000 college students concluded that the overall frequency of binge drinking increases the risk of negative alcohol-related outcomes.[49] Specifically, students who binge drank three or more times in a 2-week period were twice as likely as students who binge drank once or twice in the same time period to experience alcohol-induced memory losses (27% vs. 54%), to not use protection during sex (10% vs. 20%), to engage in unplanned sex (22% vs. 42%), and to be injured (11% vs. 27%). Both groups were at a 1% risk of needing medical treatment for an overdose.

As mentioned earlier, students who binge drink regularly drink well over the typical binge threshold, making it difficult to determine, at a population level, whether the increase in risk associated with frequent binging results from the number of binge episodes per se, or from the number of drinks consumed in an episode.[4] Wechsler and Nelson concluded that, for individuals, the odds of experiencing alcohol-related harms rise as their level of alcohol consumption increases.[50] Mundt and colleagues reported that, among 2,090 college students, having an alcohol-related injury became 19% more likely for men with each additional day of consuming 8 or more drinks and 10% more likely for women drinking 5 or more drinks.[51] Read and colleagues also found that when they distinguished between nonbinge drinkers, binge drinkers (4+/5+), and heavy binge drinkers (6+/7+) in a sample of 356 college students, only the heavy binge drinkers differed significantly from the nonbinge drinkers on measures of alcohol-related consequences, including blacking out, impaired control, and alcohol dependence symptoms.[13] In a sample of 115 young adults, Jackson found that a threshold of 10 or more drinks was most predictive of hangover when examining the relationship between alcohol-related consequences and different drinking thresholds (from 1+ to 15+ drinks per occasion).[52]

Much of the research on the adverse consequences of consuming alcohol examines global associations between overall drinking levels and overall rates of consequences. Neal and Fromme attempted to assess whether alcohol consumption could be directly associated with specific behavioral consequences by asking college students to monitor their behavior over 30 days.[31] Their analysis included data from 691 women and 422 men on a total of 30,224 days. They concluded that, on a global level, average BAC was significantly correlated with illicit drug use, drinking and driving, engaging in sexual behavior, having unsafe sex, being the victim of coerced sex, being the perpetrator of coerced sex, acting aggressively, and gambling. Their analysis also found strong event-level associations between BAC and several behavioral risks, with the strongest correlations for vandalism, and the weakest for aggressive behavior and unsafe sex. They estimated that every .01 increase in BAC was associated with a 4% to 12% increase in the risk of engaging in these behaviors. Those numbers become significant when people engage in high-intensity drinking, which can increase BAC quickly in a short amount of time.

Several studies indicate that college students who engage in high-intensity drinking are motivated in large part by the expectation that it will lead to positive consequences, including being more social and having fun with friends. And these positive consequences may outweigh any potential negative consequences. In a longitudinal study that surveyed 342 college students over a total of 4,645 days, Patrick and colleagues found that students, in fact, both expected and experienced more positive consequences on days that they engaged in high-intensity drinking.[12] Students also expected and experienced more negative consequences on high-intensity drinking days. Furthermore, the positive consequences were rated as better and the negative consequences were rated as worse on high-intensity drinking days. Students may be motivated by the positive consequences and

accept the negative consequences as part of the drinking experience.

Self-Report of High-Intensity Drinking

When studying binge drinking, or any type of alcohol consumption, it is critical that researchers have access to an accurate and straightforward method for measuring how much alcohol people ingest. Most studies rely on self-reports, although questions have been raised about how valid those reports are at high quantities of alcohol. Recently, studies that compare self-reports with biological measures of alcohol consumption have determined that self-reports are a valid way to assess alcohol consumption.[53] That said, some evidence suggests that self-report data break down after people consume large amounts of alcohol. Northcote and Livingston, for example, found that young adults accurately estimated their alcohol consumption when it was light or moderate but underestimated it after eight or more drinks.[54] These discrepancies may result from a combination of intoxication interfering with memory and a desire to provide a more socially acceptable response.

Conclusions

Research has established that high-intensity drinking is relatively common, especially among teens and young adults, and it appears to peak around age 21. These findings suggest that studies should distinguish between standard binge drinking (4+/5+) and drinking that far exceeds that cutoff. To date, the few studies that measure high-intensity drinking, defined as drinking two or three times as much alcohol (e.g., 10+ or 15+ drinks) as a typical binge episode, suggest that it is far riskier and has major implications for individual and community health. As this field matures, it will be critical to further examine gender-specific measures for high-intensity alcohol use (e.g., 8+/10+ and 12+/15+ drinks for women/men) and to include effects of age in relevant analyses. Indeed, high-intensity drinking behavior is particularly dangerous for teens, whose brains are still developing and who may be more vulnerable to developing alcohol use disorder.

Future research in this area should focus on the initiation and progression of high-intensity drinking.[11] Additional research is also needed to determine whether existing prevention approaches are effective at reducing high-intensity drinking, or whether more prevention and intervention programs are needed to address this more extreme behavior.[11,16] Understanding who is most likely to engage in high-intensity drinking and when and where that drinking occurs will help design prevention programs to specifically target this behavior.

Acknowledgments

This study was funded by support from NIAAA (R01-AA- 023504 to Dr. Patrick). The content here is solely the responsibility of the authors and does not necessarily represent the official views of the sponsors.

Financial Disclosure

The authors declare that they have no competing financial interests.

References

1. Johnson G, Guha IN, Davies P. Were James Bond's drinks shaken because of alcohol induced tremor? *BMJ.* 2013;12(347):f7255. PMID: 24336307.
2. Wechsler H, Davenport A, Dowdall G, et al. Health and behavioral consequences of binge drinking in college: A national survey of students at 140 campuses. *JAMA.* 1994;272(21):1672-1677. PMID: 7966895.
3. National Institute on Alcohol Abuse and Alcoholism (NIAAA). NIAAA Council approves definition of binge drinking. *NIAAA Newsletter.* Winter 2004;(3):3. https://pubs.niaaa.nih.gov/publications/Newsletter/winter2004/Newsletter_Number3.pdf. Accessed July 13, 2017.
4. White A, Hingson R. The burden of alcohol use: Excessive alcohol consumption and related consequences among college students. *Alcohol Res.* 2013;35(2):201-218. PMID: 24881329.
5. Cederbaum AI. Alcohol metabolism. *Clin Liver Dis.* 2012;16(4):667-685. PMID: 23101976.
6. Spear LP. Adolescents and alcohol: Acute sensitivities, enhanced intake, and later consequences. *Neurotoxicol Teratol.* 2014;41:51-59. PMID: 24291291.
7. Pearson MR, Kirouac M, Witkiewitz K. We still question the utility and validity of the binge/heavy drinking criterion. *Addiction.* 2016;111(10):1733-1734. PMID: 27137172.
8. Ogden CL, Fryar CD, Carroll MD, et al. Mean body weight, height, and body mass index, United States 1960–2002. *Adv Data.* 2004;347:1-17. https://www.cdc.gov/nchs/data/ad/ad347.pdf. Accessed December 22, 2016.
9. White AM, Kraus CL, Swartzwelder H. Many college freshmen drink at levels far beyond the binge threshold. *Alcohol Clin Exp Res.* 2006;30(6):1006-1010. PMID: 16737459.
10. Patrick ME, Schulenberg JE, Martz ME, et al. Extreme binge drinking among 12th-grade students in the United States: Prevalence and predictors. *JAMA Pediatr.* 2013;167:1019-1025. PMID: 24042318.
11. Patrick ME. A call for research on high-intensity alcohol use. *Alcohol Clin Exp Res.* 2016;40(2):256-259. PMID: 26842244.
12. Patrick ME, Cronce JM, Fairlie AM, et al. Day-to-day variations in high-intensity drinking, expectancies, and positive and negative alcohol-related consequences. *Addict Behav.* 2016;58:110-116. PMID: 26922158.
13. Read JP, Beattie M, Chamberlain R, et al. Beyond the "binge" threshold: Heavy drinking patterns and their association with alcohol involvement indices in college students. *Addict Behav.* 2008;33(2):225-234. PMID: 17997047.
14. Patrick ME, Terry-McElrath YM. High-intensity drinking by underage young adults in the United States. *Addiction.* 2017;112(1):82-93. PMID: 27514864.
15. Patrick ME, Terry-McElrath YM, Kloska DD, et al. High-intensity drinking among young adults in the United States: Prevalence, frequency, and developmental change. *Alcohol Clin Exp Res.* 2016;40(9):1905-1912. PMID: 27488575.
16. Hingson RW, White A. Trends in extreme binge drinking among U.S. high school seniors. *JAMA Pediatr.* 2013;167(11):996-998. PMID: 24042186.
17. Terry-McElrath YM, Patrick ME. Intoxication and binge and high-intensity drinking among U.S. young adults in their mid-20s. *Subst Abuse.* 2016;37(4):597-605. PMID: 27092592.
18. Naimi TS, Nelson DE, Brewer RD. The intensity of binge alcohol consumption among U.S. adults. *Am J Prev Med.* 2010;38(2):201-207. PMID: 20117577.

19. Donovan JE. Estimated blood alcohol concentrations for child and adolescent drinking and their implications for screening instruments. *Pediatrics.* 2009;123(6):e975-e981. PMID: 19482748.

20. Jacobus J, Tapert SF. Neurotoxic effects of alcohol in adolescence. *Ann Rev Clin Psychol.* 2013;9:703-721. PMID: 23245341.

21. Lacaille H, Duterte-Boucher D, Liot D, et al. Comparison of the deleterious effects of binge drinking-like alcohol exposure in adolescent and adult mice. *J Neurochem.* 2015;132(6):629-641. PMID: 25556946.

22. Parikh RB, Junquera P, Canaan Y, et al. Predictors of binge drinking in elderly Americans. *Am J Addict.* 2015;24(7):621-627. PMID: 26300301.

23. Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Substance Abuse Treatment. *Substance Abuse Among Older Adults.* Treatment Improvement Protocol (TIP) Series, No. 26. Rockville, MD: U.S. Department of Health and Human Services; 1998. https://www.ncbi.nlm.nih.gov/books/NBK64419. Accessed July 14, 2017.

24. Schuckit MA, Smith TL, Clausen P, et al. Drinking patterns across spring, summer, and fall in 462 university students. *Alcohol Clin Exp Res.* 2016;40(4):889-896. PMID: 27038597.

25. Bellis MA, Hughes K, Jones L. Holidays, celebrations, and commiserations: Measuring drinking during feasting and fasting to improve national and individual estimates of alcohol consumption. *BMC Med.* 2015;13:113. PMID: 25998218.

26. Del Boca FK, Darkes J, Greenbaum PE, et al. Up close and personal: Temporal variability in the drinking of individual college students during their first year. *J Consult Clin Psychol.* 2004;72(2):155-164. PMID: 15065951.

27. Goldman MS, Greenbaum PE, Darkes J, et al. How many versus how much: 52 weeks of alcohol consumption in emerging adults. *Psychol Addict Behav.* 2011;25(1):16-27. PMID: 21219038.

28. Kushnir V, Cunningham JA. Event-specific drinking in the general population. *J Stud Alcohol Drugs.* 2014;75(6):968-972. PMID: 25343654.

29. Neighbors C, Atkins DC, Lewis MA, et al. Event-specific drinking among college students. *Psychol Addict Behav.* 2011;25(4):702-707. PMID: 21639597.

30. Green K, Nelson TF, Hartmann D. Binge drinking and sports participation in college: Patterns among athletes and former athletes. *Int Rev Sociol Sport.* 2014;49(3/4):417-443. doi:10.1177/1012690213509257.

31. Neal DJ, Fromme K. Event-level covariation of alcohol intoxication and behavioral risks during the first year of college. *J Consult Clin Psychol.* 2007;75(2):294-306. PMID: 17469887.

32. Grekin ER, Sher KJ, Krull JL. College spring break and alcohol use: Effects of spring break activity. *J Stud Alcohol Drugs.* 2007;68(5):681-688. PMID: 17690801.

33. Lee CM, Maggs JL, Rankin LA. Spring break trips as a risk factor for heavy alcohol use among first-year college students. *J Stud Alcohol.* 2006;67(6):911-916. PMID: 17061009.

34. Lee CM, Lewis MA, Neighbors C. Preliminary examination of spring break alcohol use and related consequences. *Psychol Addict Behav.* 2009;23(4):689-694. PMID: 20025375.

35. Neighbors C, Spieker CJ, Oster-Aaland L, et al. Celebration intoxication: An evaluation of 21st birthday alcohol consumption. *J Am Coll Health.* 2005;54(2):76-80. PMID: 16255318.

36. Rutledge PC, Park A, Sher KJ. 21st birthday drinking: Extremely extreme. *J Consult Clin Psychol.* 2008;76(3):511-516. PMID: 18540744.

37. Lefkowitz ES, Patrick ME, Morgan NR, et al. State Patty's Day: College student drinking and local crime increased on a student-constructed holiday. *J Adolesc Res.* 2012;27(3):323-350. PMID: 22685369.

38. Dearing RL, Twaragowski C, Smith PH, et al. Super Bowl Sunday: Risky business for at-risk (male) drinkers? *Subst Use Misuse.* 2014;49(10):1359-1363. PMID: 24621086.

39. Merlo LJ, Ahmedani BK, Barondess DA, et al. Alcohol consumption associated with collegiate American football pre-game festivities. *Drug Alcohol Depend.* 2011;116(1-3):242-245. PMID: 21288661.

40. Nelson TF, Wechsler H. School spirits: Alcohol and collegiate sports fans. *Addict Behav.* 2003;28(1):1-11. PMID: 12507523.

41. Veliz P, McCabe SE, Boyd CJ. Extreme binge drinking among adolescent athletes: A cause for concern? *Am J Addict.* 2016;25(1):37-40. PMID: 26688434.

42. Callaghan RC, Sanches M, Gatley JM, et al. Hazardous birthday drinking among young people: Population-based impacts on emergency department and in-patient hospital admissions. *Addiction.* 2014;109(10):1667-1675. PMID: 25047919.

43. Brister HA, Wetherill RR, Fromme K. Anticipated versus actual alcohol consumption during 21st birthday celebrations. *J Stud Alcohol Drugs.* 2010;71(2):180-183. PMID: 20230714.

44. Neighbors C, Rodriquez LM, Rinker DV, et al. Drinking games and contextual factors of 21st birthday drinking. *Am J Drug Alcohol Abuse.* 2014;40(5):380-387. PMID: 25192206.

45. Patrick ME, Lee CM. Daily variations in spring break alcohol and sexual behaviors based on intentions, perceived norms, and daily trip context. *J Stud Alcohol Drugs.* 2012;73(4):591-596. PMID: 22630797.

46. Patrick ME, Schulenberg JE, O'Malley PM, et al. Adolescents' reported reasons for alcohol and marijuana use as predictors of substance use and problems in adulthood. *J Stud Alcohol Drugs.* 2011;72(1):106-116. PMID: 21138717.

47. Litt DM, Lewis MA, Patrick ME, et al. Spring break versus spring broken: Predictive utility of spring break alcohol intentions and willingness at varying levels of extremity. *Prev Sci.* 2014;15(1):85-93. PMID: 23404667.

48. Schulenberg JE, Patrick ME, Kloska DD, et al. Substance use disorder in early midlife: A national prospective study on health and well-being correlates and long-term predictors. *Subst Abuse.* 2016;9(suppl 1):41-57. PMID: 27257384.

49. Wechsler H, Nelson TF. What we have learned from the Harvard School of Public Health College Alcohol Study: Focusing attention on college student alcohol consumption and the environmental conditions that promote it. *J Stud Alcohol Drugs.* 2008;69(4):481-490. PMID: 18612562.

50. Wechsler H, Nelson TF. Binge drinking and the American college student: What's five drinks? *Psychol Addict Behav.* 2001;15(4):287-291. PMID: 11767258.

51. Mundt MP, Zakletskaia LI, Fleming MF. Extreme college drinking and alcohol-related injury risk. *Alcohol Clin Exp Res.* 2009;33(9):1532-1538. PMID: 19485974.

52. Jackson KM. Heavy episodic drinking: Determining the predictive utility of five or more drinks. *Psychol Addict Behav.* 2008;22(1):68-77. PMID: 18298232.

53. Simons JS, Wills TA, Emery NN, et al. Quantifying alcohol consumption: Self-report, transdermal assessment, and prediction of dependence symptoms. *Addict Behav.* 2015;50:205-212. PMID: 26160523.

54. Northcote J, Livingston M. Accuracy of self-reported drinking: Observational verification of "last occasion" drink estimates of young adults. *Alcohol.* 2011;46(6):709-713. PMID: 21949190.