Published in final edited form as:

Am J Drug Alcohol Abuse. 2012 July ; 38(4): 322–327. doi:10.3109/00952990.2011.643981.

High-Risk Driving Behaviors among Adolescent Binge-Drinkers

Thomas D. Marcotte, Ph.D.¹, Nicole M. Bekman, Ph.D.¹, Rachel A. Meyer¹, and Sandra A. Brown, Ph.D.^{2,1}

¹Department of Psychiatry, University of California, San Diego, CA, USA

²Departments of Psychology and Psychiatry, University of California, San Diego, CA, USA

Abstract

Background—Binge drinking is common among adolescents. Alcohol use, and binge-drinking in particular, has been associated with neurocognitive deficits as well as risk-taking behaviors, which may contribute to negative driving outcomes among adolescents even while sober.

Objectives—To examine differences in self-reported driving behaviors between adolescent binge-drinkers and a matched sample of controls, including (a) compliance with graduated licensing laws, (b) high risk driving behaviors, and (c) driving outcomes (crashes, traffic tickets).

Methods—The present study examined driving behaviors and outcomes in adolescent recent binge drinkers (n=21) and demographically and driving history matched controls (n=17), ages 16-18.

Results—Binge drinkers more frequently violated graduated licensing laws (e.g., driving late at night), and engaged in more “high risk” driving behaviors, such as speeding and using a cell-phone while driving. Binge drinkers had more traffic tickets, crashes and “near crashes” than the control group. In a multivariate analysis, binge drinker status and speeding were the most robust predictors of a crash.

Conclusion—Binge drinking teens consistently engage in more dangerous driving behaviors and experience more frequent crashes and traffic tickets. They are also less compliant with preventative restrictions placed on youth while they are learning critical safe driving skills.

Scientific Significance—These findings highlight a need to examine the contribution of underlying traits (such as sensation seeking) and binge-related cognitive changes to these high-risk driving behaviors, which may assist researchers in establishing alternative prevention and policy efforts targeting this population.

Keywords

adolescent alcohol use; graduated licensing laws; risky driving

Alcohol use (1) and binge drinking (2) are frequent among adolescents in the United States. While alcohol use has been associated with neurocognitive deficits in adolescents (3), animal studies suggest that repeated exposure to alcohol followed by withdrawal, similar to binge-drinking, may be particularly damaging to the developing adolescent brain (4). Binge drinking in adolescence is also associated with risk behaviors such as sexual activity, smoking, attempting suicide, and driving after drinking.

A key milestone for adolescents is learning to drive and being granted permission to do so autonomously. This newfound autonomy comes with risks: in the United States, traffic accidents are the leading cause of teenage deaths (5) and, adjusting for mileage, drivers 16-19 year olds are four times more likely to crash than older drivers (6). In addition, compared to adults, the likelihood of an adolescent being involved in a fatal crash increases more sharply with higher blood alcohol levels (7).

Graduated driver licensing (GDL) is one approach to reducing teen crash rates. Under GDL, new drivers typically complete 1) a learning phase under adult supervision, 2) an intermediate phase where supervision is required under high-risk conditions, 3) granting of an unrestricted license (8). States implementing GDL rated “good”, such as California (site of this study), exhibit a 30 percent lower fatal crash rate among 15-17 year olds compared to states with a “poor” rating (8).

The goal of this study was to examine the degree to which adolescent binge-drinking is associated with compliance with GDL, high risk driving behaviors, and driving outcomes (crashes, traffic tickets) within carefully matched groups of 16 to 18 year old binge drinkers and non-drinking adolescents.

Methods

Participants

Adolescent binge-drinkers (ABD) and matched non-drinking controls (CON), ages 16-18 years old, were recruited from school districts/communities as part of a longitudinal study. ABD reported > 100 occasions of alcohol use, had 3 periods of heavy drinking (5 drinks per occasion) episodes in the past month, experienced 1 withdrawal symptom following a recent drinking episode, and had limited exposure to other substances. Controls had little or no alcohol/drug experience and no history of alcohol/drug problems. Exclusion criteria included: parent/guardian did not agree to corroborate participant’s history, living > 50 miles from research site, psychiatric or neurologic diagnosis, head trauma with 2 minutes loss of consciousness, not speaking English, or history of substance abuse/dependence or recent regular drug use. All participants had a valid driver’s or provisional license, and recently drove.

The sample consisted of 21 ABD and 17 CON. The groups were well-matched on age ($m = 17.76$ years old, $SD = .78$), education ($m = 11.13$ years, $SD = .84$), gender (47% male), and race (71% white), as well as years driving ($m = 1.58$ and 2.28 years, $SD = .85$ and 1.84 , respectively), and recent driving ($m = 361.53$ and 334.67 miles/month, $SD = 259.79$ and 238.19).

ABD had more average ($m = 5.10$, $SD = 1.61$) and maximum drinks ($m = 9.90$, $SD = 3.71$) per drinking day in the past three months, and more occasions in which they had been drunk in their lifetime ($m = 153.52$, $SD = 70.31$). CON reported < 1 maximum drink in the past three months and < 1 occasion of lifetime drunkenness ($m = 0.1$, $SD = 1.2$). Fifty-three percent of the sample reported lifetime exposure to marijuana and 21% had used other substances. Among youth with substance use, the most recent marijuana use was on average 141.25 days prior to assessment ($SD = 245.53$) and 316.64 days prior for other drugs ($SD = 339.14$). None reported alcohol/drug use problems or met DSM criteria for abuse or dependence.

Procedure

All teens and their parents provided informed consent/assent in compliance with the University of California, San Diego Human Research Protection Program.

Measures

Timeline Followback (TLFB) (9): Assesses alcohol and other drug use for 45 days prior to the initial assessment.

Customary Drinking and Drug Use Record (CDDR) (10): Assesses alcohol, nicotine, marijuana and other drug use, withdrawal symptoms, DSM-IV abuse and dependence criteria, substance-related problems, and intentions to quit. Although adolescents typically provide valid self-reports (11), we also collected corroborative information (breathalyzer samples, toxicology screens, parental report).

UCSD Self-Report Driving Questionnaire (adapted from (12)): Assesses driving experience, crash and traffic ticket history, and frequency of high-risk roadway and in-car behaviors (Table 1).

For the California GDL process, the first 50 hours of driving (learner's permit) are supervised by a parent/guardian, adult > 25 years of age, or driving instructor. Once completed, and passing a behind-the-wheel driving test, teens are given a provisional license. For the next 12 months the teen driver may not do the following without a licensed driver age ≥ 25 years of age present: 1) have passengers < 20 years old, b) drive between 11pm and 5am, or c) transport passengers < 20 years old. Once the driver is 16 and completes these steps, and has no outstanding restrictions, suspensions or probations, the driver receives a license with full privileges. We thus queried participants about compliance with these processes.

Statistical Analyses—Comparisons on continuous variables that met assumptions regarding outliers and non-normal distributions were performed using independent t-tests. If the distribution was not normal, we employed nonparametric Wilcoxon rank-sum tests. For categorical variables, we used a chi-square test of independence, and the Fisher Exact Test if expected cell counts < 5.

Logistic regression models were used to predict whether a participant had a real-world crash (crash/no crash). Potential predictors were first grouped by theme (e.g., binge-drinker status; driving exposure [mileage, years driving]; high-risk driving behaviors [speeding, running yellow lights, etc.]; in-car multi-tasking). Forward stepwise modeling identified the significant predictors from each group, eliminating redundant information. Variables showing significance were then combined for the final analyses, which utilized a step-wise approach to determine the most parsimonious model. The odds ratio (probability of a crash vs. no crash) was calculated using logistic regression, with the low risk condition (e.g., CON group, non-speeders) as the reference group. Analyses were performed using JMP, v. 8 (13).

Results

Compliance with graduated licensing laws (GDL)

ABD more frequently violated GDL, breaking the laws a median of 60 times vs. 9 times for CON (Table 1). There was a trend for the ABD group to violate the first step (learner's permit) by driving more often without a guardian. At the provisional stage, ABD group drove more times without a guardian, particularly late at night.

High-risk driving behaviors

Over half of ABD youth reported speeding, running yellow lights, and dangerous passing compared to approximately one in five CON (Table 1). There was also a trend for ABD's to race other cars more often ($p = .07$). ABD exhibited more risky in-car behaviors, such as

routinely changing music ($p = .04$) and talking on cell-phones ($p = .01$). Although not common, ABD were more likely to have texted while driving ($p = .007$).

Driving outcomes

Fifteen participants (39.5%) reported crashes in which they were the driver. Most were “minor” (no injuries or significant property damage). Two participants (both ABD) had a serious crash. ABD had a higher rate, as well as a higher number ($mdn = 1$ vs. $mdn = 0$ for CON; $p < .02$) of crashes. Adjusting for risk exposure (years driving), ABD had an odds ratio of 7.27 ($CI = 1.53-45.72$) for a crash relative to CON. ABD also more “near crashes” (needing to swerve or hit brakes to avoid a crash), and higher frequency of traffic tickets.

Risk factors for automobile crashes

To understand the relationship of binge drinking history and risk behaviors to crashes, we entered potential risk factors (based upon conceptual grouping) into a model predicting crash/no crash. At the univariate level, binge-drinker status predicted a crash ($OR = 6.22$, $CI = 1.36, 28.37$; $p = .011$). Among “exposure” variables, years of driving was associated with crash history ($OR = 2.42$, $CI = 1.20, 6.11$; $p = .014$), with mileage per month approaching significance ($OR = 1.32$, $CI = .99, 1.84$; $p = .054$); in a stepwise regression model, years driving was the only significant predictor ($p = .01$). Of the in-car behaviors, using a cell phone more than “rarely” ($OR = 4.25$, $CI = 1.06, 17.07$; $p = .04$) was significant; ever texting ($OR = 5.42$, $CI = 0.98, 29.02$; $p = .07$) and routinely changing music ($OR = 3.40$, $CI = 0.88, 13.39$; $p = .07$) bordered on significance; only “ever texted” entered the stepwise model ($p = .03$). Among on-road behaviors, speeding was significant, ($OR = 7.79$, $CI = 1.78, 34.06$; $p = .007$), with running yellow lights ($OR = 3.24$, $CI = .82, 12.82$; $p = .08$) approaching significance. Only speeding entered the stepwise model ($p = .004$). Of the alcohol-related items, ever driving under the influence predicted crashes ($OR = 5.42$, $CI = 1.24, 23.86$; $p = .02$). None of the GDL items predicted crashes.

We next conducted a stepwise logistic regression analysis to jointly consider the significant predictors of driver crash history noted above. Predictors included binge-drinker status (ABD/CON), years of driving, history of text messaging, history of speeding, and ever driving under the influence. Speeding and ABD/CON sequentially entered the model ($p < .05$) and jointly accounted for 23% of the teen crashes. The adjusted odds ratios were 4.93 ($CI = 1.02, 29.67$; $p = .047$) for ABD/CON and 6.4 ($CI = 1.43, 34.21$; $p = .025$) for speeding. No other variables were significant predictors.

Discussion

In carefully matched samples of binge-drinking and non-drinking adolescent drivers, we found that heavy drinking youth reported more automobile crashes and more traffic tickets in their brief driving history. Not surprisingly, binge-drinking teens were more likely to drive after using alcohol or drugs, although this was not a frequent occurrence (self-reported median of 2 times in life). While previous large-scale surveys found that binge-drinking adolescents are more likely to drive after drinking (14, 15), these studies often lack details on specific in car and on-road risk behaviors and outcomes. To our knowledge, the present study is the first to demonstrate increased crash rates for adolescent binge drinkers.

High-risk behaviors are elevated among teens (16), and further elevated in adolescent binge drinkers (17). Binge-drinkers in our study were more likely to engage in risky driving, such as speeding, running yellow lights, racing other cars, and passing in no-passing lanes. They were also more likely to behave in a manner that took their attention from the roadway, including changing their music and, using cell-phones, and text messaging while driving.

Such multi-tasking increases cognitive workload, reducing attentional efficiency (18); inattention is a common cause of automobile crashes (19).

GDL is effective in lowering teen crash rates (8, 20). However, we found that binge drinking youth failed to follow these rules at high rate (e.g., driving with passengers < 20 years old without a guardian at a 5-times higher rate and violating late night driving restrictions 30 times more often than non-drinkers). Binge-drinking teens may thus require additional interventions to ensure GDL compliance.

We also sought to identify risk factors for a crash. Univariately, factors such as driving exposure, risky in-car and on-road behaviors, and driving under the influence were associated crashes. However, the most parsimonious multivariate model included only speeding and binge-drinker status. It is possible that binge drinker status accounts for many, if not all, of the high-risk behaviors and thus itself is the most “parsimonious” explanatory variable. In addition, binge-drinker status may capture unmeasured characteristics, such as poor judgment, risk taking tendencies, lower self-regulation, or cognitive deficits associated with recent high dose alcohol exposure.

Although the etiology for these high-risk driving behaviors cannot be addressed by this study, such an understanding is critical for effective prevention efforts. Dangerous driving may represent an underlying trait, such as impulsivity, risk taking or altered executive functioning. While such tendencies are common during adolescence, they are particularly salient in adolescents with early-onset alcohol problems (21). Such propensities may be exacerbated by binge-drinking, where the exposure and withdrawal cycle is particularly damaging in the maturing brain. Onset of binge drinking during adolescence alters brain morphology (22), and heavy drinking is associated with deficits in visuospatial functioning and memory retrieval (3). Animal studies indicate that repeated high dose alcohol exposure and withdrawal may be neurotoxic to the hippocampus (23), and affect serotonergic functioning (24), with the greatest damage in the frontal association cortex and other frontal regions. Damage to regions affecting executive functioning could impact key developmental processes in the maturing adolescent brain, including inhibitory control and self-monitoring (17), and possibly result in increased risk-taking. Following adolescents who become abstinent may help answer whether these driving behaviors change in the context of neurocognitive recovery.

There are limitations to the current study. As the sample size is small, these findings are only preliminary and need to be replicated in larger samples. The driving data were based upon self-report; however, crashes are vastly underreported to the authorities (25), and self-report enabled us to examine minor crashes and near-crashes. Crashes reported by binge drinkers may have occurred while they were intoxicated, although it is unlikely as they reported few such episodes (median of 2). As lifetime and recent use of other substances was quite limited, we were unable to examine how other drug exposure may have influenced the driving behavior of these binge-drinking youth.

In summary, this study provides preliminary evidence that binge-drinking adolescents, none of whom met criteria for an alcohol use disorder, are more likely to experience crashes, receive traffic tickets, violate key components of graduated licensing regulations, and engage in dangerous in-car and on-road behaviors. These findings highlight a public health need to better determine factors that influence these high-risk behaviors, such as premorbid personality traits and cognitive deficits induced by a repeated pattern of high-dose alcohol exposure and withdrawal. The results also indicate that additional approaches to implementing the graduating licensing process may be needed in subsets of teen drivers, such as individuals prone to or engaging in binge-drinking. Future research clarifying the

mechanisms by which adolescent binge drinkers are more risky drivers will assist researchers in establishing alternative prevention and policy efforts targeting this population.

Acknowledgments

Portions of this study were funded by the following grants and fellowships: R21 AA017321 (PI: S. Brown), R01 AA12171-09 (PI: S. Brown) and T32 AA013525 (Fellow: N. Bekman; PI: E. Riley).

References

1. Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future: National Survey Results on Drug Use, 1975-2005. National Institute on Drug Abuse; Bethesda, MD: 2006.
2. O'Malley PM, Johnston LD, Bachman JG, Schulenberg JE, Kumar R. How substance use differs among American secondary schools. *Prev Sci.* 2006; 7(4):409–420. [PubMed: 16900406]
3. Brown SA, Tapert SF, Granholm E, Delis DC. Neurocognitive functioning of adolescents: effects of protracted alcohol use. *Alcohol Clin Exp Res.* 2000; 24(2):164–171. [PubMed: 10698367]
4. Crews FT, Braun CJ, Hoplight B, Switzer RC 3rd, Knapp DJ. Binge ethanol consumption causes differential brain damage in young adolescent rats compared with adult rats. *Alcohol Clin Exp Res.* 2000; 24(11):1712–1723. [PubMed: 11104119]
5. Centers for Disease Control and Prevention. National Center for Injury Prevention and Control, Centers for Disease Control and Prevention (producer); 2009. Web-based Injury Statistics Query and Reporting System (WISQARS).
6. Insurance Institute for Highway Safety (IIHS). Fatality facts: teenagers 2008. Arlington, VA: 2009.
7. Zador PL, Krawchuk SA, Voas RB. Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. *J Stud Alcohol.* 2000; 61(3):387–395. [PubMed: 10807209]
8. McCartt AT, Teoh ER, Fields M, Braitman KA, Hellinga LA. Graduated licensing laws and fatal crashes of teenage drivers: a national study. *Traffic Inj Prev.* 2010; 11(3):240–248. [PubMed: 20544567]
9. Sobell LC, Maisto SA, Sobell MB, Cooper AM. Reliability of alcohol abusers' self-reports of drinking behavior. *Behav Res Ther.* 1979; 17(2):157–160. [PubMed: 426744]
10. Brown SA, Myers MG, Lippke L, Tapert SF, Stewart DG, Vik PW. Psychometric evaluation of the Customary Drinking and Drug Use Record (CDDR): a measure of adolescent alcohol and drug involvement. *J Stud Alcohol.* 1998; 59(4):427–438. [PubMed: 9647425]
11. Winters KC, Stinchfield RD, Henly GA, Schwartz RH. Validity of adolescent self-report of alcohol and other drug involvement. *Int J Addict.* 1990; 25(11A):1379–1395. [PubMed: 2132719]
12. Marcotte TD, Wolfson T, Rosenthal TJ, Heaton RK, Gonzalez R, Ellis RJ, Grant I. A multimodal assessment of driving performance in HIV infection. *Neurology.* 2004; 63(8):1417–1422. [PubMed: 15505158]
13. SAS Institute Inc.. JMP Statistics and Graphics Guide, Version 8.0. SAS Institute, Inc.; Cary, North Carolina: 2009.
14. Escobedo LG, Chorba TL, Waxweiler R. Patterns of alcohol use and the risk of drinking and driving among US high school students. *Am J Public Health.* 1995; 85(7):976–978. [PubMed: 7604923]
15. Miller JW, Naimi TS, Brewer RD, Jones SE. Binge drinking and associated health risk behaviors among high school students. *Pediatrics.* 2007; 119(1):76–85. [PubMed: 17200273]
16. Reyna VF, Farley F. Risk and rationality in adolescent decision making: implications for theory, practice, and public policy. *Psycho Sci Public Interest.* 2006; 7(1):1–44.
17. Brown SA, McGue M, Maggs J, Schulenberg J, Hingson R, Swartzwelder S, Martin C, Chung T, Tapert SF, Sher K, Winters KC, Lowman C, Murphy S. A developmental perspective on alcohol and youths 16 to 20 years of age. *Pediatrics.* 2008; 121(Suppl 4):S290–310. [PubMed: 18381495]
18. Strayer DL, Drews FA, Johnston WA. Cell phone-induced failures of visual attention during simulated driving. *J Exp Psychol Appl.* 2003; 9(1):23–32. [PubMed: 12710835]

19. Neale, VL.; Dingus, TA.; Klauer, SG.; Sudweeks, J.; Goodman, M. An Overview of the 100-Car Naturalistic Study and Findings, 05-0400. National Highway Traffic Safety Administration; Washington, D.C.: 2005.
20. Chen LH, Baker SP, Braver ER, Li G. Carrying passengers as a risk factor for crashes fatal to 16- and 17-year-old drivers. *JAMA*. 2000; 283(12):1578–1582. [PubMed: 10735394]
21. Hittner JB, Swickert R. Sensation seeking and alcohol use: a meta-analytic review. *Addict Behav*. 2006; 31(8):1383–1401. [PubMed: 16343793]
22. Squeglia LM, Jacobus J, Tapert SF. The influence of substance use on adolescent brain development. *Clin EEG Neurosci*. 2009; 40(1):31–38. [PubMed: 19278130]
23. Nixon K, Crews FT. Binge ethanol exposure decreases neurogenesis in adult rat hippocampus. *J Neurochem*. 2002; 83(5):1087–1093. [PubMed: 12437579]
24. Obernier JA, White AM, Swartzwelder HS, Crews FT. Cognitive deficits and CNS damage after a 4-day binge ethanol exposure in rats. *Pharmacol Biochem Behav*. 2002; 72(3):521–532. [PubMed: 12175448]
25. Fox GK, Bowden SC, Smith DS. On-road assessment of driving competence after brain impairment: review of current practice and recommendations for a standardized examination. *Arch Phys Med Rehabil*. 1998; 79(10):1288–1296. [PubMed: 9779686]

Table 1

Driving behaviors and history for adolescents (16-18 years old) with and without a history of recent binge drinking.

	Controls (n = 17) Median (IQR)	Binge Drinkers (n = 21) Median (IQR)	P
<u>Disobeying Graduated Driving Laws</u>			
Times broken any provisional driving laws ¹	9 (1.5, 45.5)	60 (26, 211.5)	0.005
Learners permit: Times driven without a guardian ¹	0 (0, 1)	1 (0, 7.8)	0.11
Provisional license:			
Times driven with passenger under age 20 without guardian ¹	6.5 (0.5, 37.5)	30 (14.3, 162.5)	0.053
Times driven between 11pm and 5am without guardian ¹	0.5 (0, 3.5)	15 (3.5, 52.5)	0.001
<u>High Risk Driving Behaviors</u>			
Routinely speed (> 6 mph) in 35 or 65 mph zone ²	29.40%	57.10%	0.09
Run yellow lights ²	17.70%	52.40%	0.03
Pass other vehicles in no-passing lane ²	17.70%	57.10%	0.01
Race other car ³	11.80%	42.90%	0.07
Times driven after alcohol/drug use ¹	0 (0,0)	2 (0.5, 5.5)	< 0.0001
<u>Risky In-Car Behaviors while Driving</u>			
Change music ²	23.50%	60.00%	0.04
Use cell phone ²	17.70%	57.10%	0.01
Ever Text message ²	43.80%	85.70%	0.007
Do not always wear seatbelt ³	11.80%	19.00%	0.67
<u>Negative Driving Outcomes</u>			
Received traffic tickets ³	5.90%	33.30%	0.05
Experienced one or more crashes ²	17.70%	57.10%	0.01
Number of near crashes ¹	2 (1.0, 2.0)	5 (1.5, 7.5)	0.007
Crashes/million miles ¹	0 (0, 0)	136 (0, 331)	0.02
Crashes/years driven ¹	0 (0, 0)	.34 (0, 0.83)	0.01

Notes:

¹Median (IQR) & Wilcoxon rank sums test;

²Percentages & Chi-square test;

³Fisher exact test