



PERGAMON

Accident Analysis and Prevention 35 (2003) 161–166

**ACCIDENT
ANALYSIS
&
PREVENTION**

www.elsevier.com/locate/aap

Correlation between modes of drinking and modes of driving as reported by students at two American universities

John D. Clapp^{a,*}, Audrey M. Shillington^a, James E. Lange^a, Robert B. Voas^b

^a San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-4119, USA

^b Pacific Institute for Research and Evaluation, 11710 Beltsville Drive, Suite 300, Calverton, MD 20705-3102, USA

Received 23 June 2001; received in revised form 10 October 2001; accepted 15 October 2001

Abstract

This paper examines the correlates and predictors of driving under the influence behaviors (DUIBs) during the past month by college students. Measures of heavy episodic drinking, monthly drinking frequency, monthly drinking variance, monthly drinks per occasion and reported marijuana use are compared as predictors net of other predictive factors. A cross-sectional telephone survey was conducted with college students by a university social science research laboratory. Respondents attended two large public universities located in the southwestern part of the US. Participants included 803 randomly selected college students. The interview schedule included items from the Core Alcohol and Drug Survey and the College Alcohol Risk Assessment Guide. Several additional last-drinking-event items were also developed for the interview. Bivariate analyses indicate that marijuana use (past year), heavy episodic drinking, reports of DUIBs (driving under the influence or riding with a driver who is under the influence) in the past year, monthly frequency of drinking, the average number of drinks consumed when drinking and age are correlates of DUIBs during the past month. Multivariate analyses indicate past year DUIBs, monthly frequency of drinking and monthly marijuana use predicted recent DUIB.

© 2002 Elsevier Science Ltd. All rights reserved.

Keywords: University students; Drinking and driving behaviors; Predictors

1. Introduction

Driving under the influence (DUI) of alcohol among college students is a serious public health problem. Given that drunk driving is among the most common risk factors for acute alcohol-related fatalities among young people (National Center for Health Statistics, 1994) and that college students are among the heaviest drinking groups in society, further examination of DUI behaviors (DUIBs) and its correlates has significance for researchers and public health professionals. This paper contributes to literature by examining the following research question: How do various measures of alcohol consumption predict the variation of (past month) drinking and driving behavior (DUIBs) among college students after controlling for demographic characteristics, marijuana use and access to a vehicle?

2. Methods

2.1. Samples

This relational study uses survey data collected as part of a federally funded alcohol prevention trial being conducted at two large public universities located in the southwestern part of the US. A total of 803 (university 1, $n = 401$; university 2, $n = 402$) undergraduate students were randomly selected from registration records at the two universities. Students refusing to participate were randomly replaced. Cooperation rates were 74.5 and 83.0%, respectively, at the two universities. For both schools, a sample of 400 students allowed for 95.0% confidence with a $\pm 5\%$ margin of error when estimating population parameters. The two study universities did not differ on gender. The universities did, however, differ statistically on race/ethnicity ($\chi^2 = 20.9$, d.f. = 5, $P = 0.001$). Percentages of Hispanic (37.0%) and White (48.0%) were comparable at each school. The two study universities differed on percentages of African Americans (9.0% versus 1.0%), Asians (11.6% versus 0%) and native Americans (2.0% versus 0%). Despite these

* Corresponding author. Tel.: +1-619-594-6859; fax: +1-619-594-5991.
E-mail address: jdclapp@mail.sdsu.edu (J.D. Clapp).

differences, preliminary analyses of the data from the two universities indicate that the schools do not differ on the DUI variables assessed in this study. As such, the data from the two schools were pooled for analysis to increase the overall sample size for the present study.

2.2. Interviews

A university-based social science research laboratory conducted telephone interviews with respondents during the spring semester of 2000. Trained interviewers conducted the interviews, which were randomly monitored by professional research staff to ensure data quality.

An original interview schedule was developed for this study. The instrument included several items from the Core Survey (Presley et al., 1995) including measures of AOD use and related problems. Presley et al. (1995) reported that the psychometric properties of the Core Survey were acceptable. In addition to the standard questions taken from the Core Survey, quantity–frequency–variability items developed by Gruenewald and Nephew (1994) were included along with several demographic items.

2.3. Measures

Three criterion variables were used in this study: (a) a variable assessing the number of times in the past 28 days students reported DUI; (b) a variable assessing the number of times in the past 28 days students reported being a passenger in a vehicle with a driver who was under the influence (RDUI); and (c) an index of drinking and driving behavior (DUIB) reflecting students' overall risk for DUI-related behavior. DUIB is the sum of each of these moderately correlated ($r = 0.55$, $P < 0.001$) behaviors (DUI + RDUI). The α value for this index is 0.70. It is important to note that each item was based on the respondents' perception of "under the influence" and not simply "driving after drinking" or driving within 2 h of drinking. However, the respondents' report of DUI represents the individual's perception of impairment and may not reflect the presence of blood alcohol concentrations (BACs) (0.08) that would meet the legal definition of driving under the influence.

Several alcohol consumption variables were identified for the study. For all alcohol consumption items, a drink was defined as one beer, one glass of wine, one mixed drink or one shot of spirits.

Consistent with Johnson et al. (1998), we defined heavy episodic drinking as five or more drinks in a single setting. Respondents were asked the number of times they engaged in this behavior in the 2-week period before being surveyed.

Respondents were also asked a series of questions about their alcohol consumption during the past 28 days. These questions included the following: (a) Thinking specifically now about the past 4 weeks, or 28 days, on how many

days, if any, did you have at least one drink of beer, wine or liquor? (b) On how many of those days (when you had a drink) did you have more than one drink? (c) On how many of those days (when you had more than one drink) did you have three or more drinks? (d) On how many of those days (when you had three or more drinks) did you have six or more drinks? These items were scored using the Consumption Models Analysis Program developed by Gruenewald and Nephew (1994). Based on the analysis of this set of questions covering the past 28 days, drinking frequency (f), mean drinks per occasion (dpo) and a drinking variance estimate (s^2) in drinks per occasion can be computed. Gruenewald et al. (1996) argued that each individual's drinking pattern can be described as a point in three-dimensional space defined by these three variables. The total consumption level can be estimated from the product of $f \times dpo$. However, frequent drinking at low levels involves a lower risk of undesirable consequences than does less frequent drinking at higher numbers of drinks per occasion. Consequently, total consumption may not provide a full measurement of the risk related to the individual's drinking pattern and alcohol-related problems, such as DUI.

To test the relative effects of the above alcohol consumption indicators, several covariates are included in this study. An index for past year DUIB was created by combining the number of times respondents reported DUI in the past year with the number of times they reported being a passenger in a vehicle driven by a drunk driver in the past year minus the respondent's DUIB (28 days) index score ($\alpha = 0.74$). This variable was included in the analyses to control for respondents' DUI history. Based on a review of other covariates of DUI, we measured and included as covariates: (a) the number of days respondents reported marijuana use in the past 28 days (Shillington and Clapp, 2001; Klepp et al., 1991); (b) gender (males = 0, females = 1) (Adebayo, 1991; MacKinnon et al., 1994; Augustyn and Simons-Morton, 1995); (c) whether the student owned or had regular access to a vehicle (0 = no, 1 = yes) (Klepp et al., 1991); and (d) age (Augustyn and Simons-Morton, 1995).

2.4. Analyses

Ordinary least squares linear multiple regression analysis, using forced entry of predictor variables, was used to identify the independent contributions of the substance use, behavioral and demographic variables to the past month DUI variables described above. The alcohol consumption indicators were collinear: Pearson's r ranged between 0.52 and 0.79. Given this, we regressed the criterion measures on each alcohol consumption indicator and the covariates in separate models. Variance inflation factor (VIF) and tolerance values for each model indicate multicollinearity was not a concern in any of the multivariate analyses. Each model had a Durbin Watson value of 1.9 indicating autocorrelation was not a concern in any of the multivariate analyses.

Table 1
Person product moment correlations, means and standard deviations for demographic, DUI and alcohol consumption variables^a

Variable	1	2	3	4	5	6	7	8	9	10	11	12	Mean	S.D.
Age (1)	–	0.11**	0.15**	–0.13**	–0.17**	–0.07	–0.19**	–0.18**	–0.17**	–0.14**	–0.17**	–0.03	24.8	8.1
Gender (2)	–	–	0.01	–0.12**	–0.15**	–0.18**	–0.25**	–0.31**	–21**	–0.10**	–0.13*	–0.82	0.55	0.50
Has regular access to car (3)	–	–	–	–0.07*	0.055	0.09**	0.07*	0.05	0.04	–0.01	–0.04	0.07	0.88	0.32
Days used marijuana (4)	–	–	–	–	0.39**	0.26**	0.24**	0.25**	0.23**	0.45**	0.47**	0.32**	0.95	3.9
Year DUIB index (5)	–	–	–	–	–	0.45**	0.50**	0.44**	0.45**	0.62**	0.71**	0.70**	1.9	3.2
Frequency of alcohol use (6)	–	–	–	–	–	–	0.59**	–0.12**	0.62**	0.34**	0.39**	0.30**	4.1	5.5
Drinks per occasion (7)	–	–	–	–	–	–	–	0.79**	0.64**	0.37**	0.38**	0.23**	1.9	1.8
Variance of drinking (8)	–	–	–	–	–	–	–	–	0.66**	0.38**	0.36**	0.22**	3.0	5.6
Heavy episodic drinking (9)	–	–	–	–	–	–	–	–	–	0.40**	0.40**	0.22**	0.64	1.6
Month DUIB index (10)	–	–	–	–	–	–	–	–	–	–	0.85**	0.74**	0.45	1.6
Rode with DUI driver (11)	–	–	–	–	–	–	–	–	–	–	–	0.55**	1.0	1.6
DUI past month (12)	–	–	–	–	–	–	–	–	–	–	–	–	0.81	1.4

^a Items 4, 6, 7, 8 and 10 are measures of the past 28 days. Item 9 is a measure of the 2 weeks before the survey.

* $P < 0.05$.

** $P < 0.001$.

3. Findings

Table 1 presents the descriptive statistics and bivariate correlations for the variables included in our analyses. As shown in the table, the mean age of respondents was almost 25 years, with a standard deviation of 8.1 years. The median age of respondents (not reported in the table) was 22 years. Females comprised 55.0% of the sample. Of all respondents, 88.0% reported owning or having regular access to a vehicle.

Overall, 21.3% of the respondents reported using marijuana at least once in the past year. Of those, 56.0% reported using marijuana at least once in the past 28 days, with an average of 0.95 times (S.D. = 3.9). Respondents reported an average frequency of alcohol consumption of 1.9 times in the past 28 days. Almost a quarter (24.4%) of the respondents reported heavy episodic drinking at least once in the past 14 days, with a mean number of 0.64 heavy episodic drinking occasions. Variance of drinking among respondents was 3.0, whereas, the average drinks per occasion for respondents was 1.9 (S.D. = 3.2).

DUI during the past year was reported by 28.1% of the respondents. Of those respondents, 40.4% reported this behavior at least once in the past 28 days, with a mean of 0.81 (S.D. = 1.4). Almost one-third (32.4%) reported being a passenger in a vehicle driven by a driver under the influence of alcohol at least once in the past year. Of those respondents reporting in the last year, 44.4% reported RDUI at least once in the 28 days before the survey. On average, respondents reported DUI within the past year 1.9 times (S.D. = 3.2), whereas, the mean DUI for the past 28 days was 0.45 (S.D. = 1.6).

Also shown in Table 1 are the correlations among the various covariates, substance use variables and DUI variables. Table 1 clearly indicates that all of the alcohol consumption variables are correlated positively and moderately to strongly with the exception of the measure of drinking variance and drinking frequency. Each of these alcohol consumption

variables is also moderately correlated with marijuana use at statistically significant levels. These alcohol consumption variables are significantly related to the DUIB index, DUI and RDUI at weak to moderate levels of magnitude.

Table 2 presents the linear multiple regression models for the monthly DUIB index and the two individual items that make up that index. These dependent measures were regressed on the alcohol consumption variables in separate models. Each model included the covariates noted above. For the DUIB index, each of the alcohol consumption variables significantly contributed in a positive direction to its respective model net of the other predictors. Beta weights for frequency of consumption, heavy episodic drinking and variance of drinking were all within 1/100 of each other in their respective models, indicating they are all equally useful in predicting DUIB. In contrast, the drinks per occasion measure yielded a smaller, but still significant, beta weight.

Overall, each of the models using the DUIB index as the criterion variable was statistically significant and explained 44.0–45.0% of the variance in the index. Of the covariates included in the models, the DUIB index for the past year was the strongest predictor of the criterion variable (both among the covariates and overall) of all the variables in the models. Interestingly, the 28-day marijuana variable was a stronger predictor of the past month DUIB index than any of the alcohol variables in each model. Finally, age, gender and vehicle access were unrelated to the 28-day DUI index in any of the models.

The regression models for the DUI (past 28 days) criterion variable differed from the DUIB index model and the RDUI models. For all of the regression models using DUI (28 days) as the criterion variable, DUIB (past year) and having regular access to a car were the only significant predictor variables. These models also each had adjusted r^2 values of 0.51.

The models using the RDUI criterion variable were similar to the DUIB models. In each of these models, the alcohol consumption predictor variable being tested significantly

Table 2
Multiple regression models for drinking driving behavior outcomes, substance use predictors and covariates

Model		Dependent measure (beta)		
		DUIB index	DUI 28 days	Rode with DUI driver (28 days)
1	Heavy episodic drinking	0.14**	-0.06	0.16**
	Age	-0.01	0.04	-0.05
	Gender	0.04	0.01	0.03
	Regular access to a car	-0.01	0.11*	-0.01
	Frequency of marijuana use (28 days)	0.25**	0.09	0.20**
	Year DUIB index	0.46**	0.71**	0.56**
	Adjusted r^2	0.45**	0.51**	0.54**
2	Variance of drinking	0.12**	-0.05	0.12*
	Age	-0.01	0.05	-0.05
	Gender	0.05	-0.01	0.02
	Regular access to a car	-0.02	0.11*	-0.04
	Frequency of marijuana use (28 days)	0.25**	0.09	0.25**
	Year DUIB index	0.48**	0.71**	0.48**
	Adjusted r^2	0.45**	0.51**	0.45**
3	Drinks per occasion	0.07*	-0.01	0.15**
	Age	-0.01	0.05	-0.04
	Gender	0.03	0.01	0.03
	Regular access to a car	-0.01	0.11*	0.00
	Frequency of marijuana use (28 days)	0.26**	0.09	0.19**
	Year DUIB index	0.49**	0.69**	0.58**
	Adjusted r^2	0.44**	0.51**	0.54**
4	Frequency of drinking	0.13**	-0.02	0.10*
	Age	-0.02	0.05	-0.07
	Gender	0.03	0.01	0.01
	Regular access to a car	-0.02	0.11*	-0.01
	Frequency of marijuana use (28 days)	0.24**	0.09	0.20**
	Year DUIB index	0.47**	0.70**	0.58**
	Adjusted r^2	0.45**	0.51**	0.53**

* $P < 0.05$.

** $P < 0.001$.

contributed to the variance explained in the model. Consistent with the models for both the DUIB index and DUI criterion variable, the past year DUIB index accounted for the largest proportions of explained variance in the models, with beta weights ranging from 0.48 to 0.58. Frequency of marijuana use also predicted RDUI in each model. In fact, in each of the models, marijuana was a stronger predictor of RDUI than the alcohol consumption variable in the model.

Given the pattern of findings presented in Table 2, we tested for the following interactions in the models: gender \times marijuana use, gender \times alcohol consumption pattern, age \times alcohol consumption pattern, age \times marijuana use, and alcohol consumption pattern \times marijuana use. None of the interaction terms statistically contributed to the models.

4. Discussion

This relational study examined the relationship of various alcohol consumption variables to drinking and driving behaviors. The data were from self-reports of college students attending two universities in the southwestern part of the US.

It was found that drinking and driving behaviors were quite high in this sample: more than 28.0% of the students queried reported such behavior during the previous year. Further, of those reporting DUI or RDUI driver in the last year, more than 44.0% reported having been involved in these behaviors during the past month. Based upon these data alone, it is clear that DUI, which is dangerous to both self and others, is a serious problem among college students.

This study found that DUIBs during the past year were the strongest predictor of drunk-driving behavior in the prior month. This is hardly surprising because past behavior is usually the best predictor of future behavior. As our data indicate, nearly half the college students involved in a DUI event in the past year will repeat that behavior in the prior month.

Of interest is our finding that access to a car and past year DUIB are the only significant predictors of past month DUI. Given that alcohol consumption is predictive of RDUI, it is possible that RDUI represents a measure of a student's willingness to risk DUI. As such, having access to a vehicle, might mediate the relationship between RDUI and DUI,

while alcohol consumption variables serve as precursors to RDUI.

DUIB and RDUI can be considered measures of exposure—exposure to DUI—and are not direct measures of crash involvement. Our results indicate that the frequency of past month DUIB and RDUI are partly a function of heavy episodic drinking, frequency of drinking or variance of drinking. It is not surprising that DUIB and RDUI are a function of the frequency of drinking nor is it unexpected that students who admit to heavy episodic drinking would report more DUIB and RDUI events. A greater variance in drinking is akin to heavy episodic drinking and, in most cases, is likely to increase the risk associated with all but very small drinks per occasion value (Gruenewald et al., 1996). The smaller relationship of drinks per occasion to reported DUI may at first seem anomalous. It suggests, however, that there may be a significant number of students drinking substantial amounts in locations where driving is not required, such as in the basement of fraternity houses.

In addition to past year drinking and driving behaviors, the report of past month marijuana use was also significantly and positively associated with reports of past month DUIB and RDUI. What is somewhat surprising about this association is that the report of marijuana use was a stronger predictor of past month DUI than were the alcohol use variables studied. There is considerable interest in the traffic safety community concerning the extent to which marijuana is a risk factor for crash involvement (De Gier, 2000). Although, the relationship between BAC and crash involvement is well established (Zador et al., 2000), the case for the significance of marijuana as a crash causation factor is more controversial and dependent on the BAC of the driver (Robbe, 1994). Although, arrested drinking drivers are frequently found to have also been using marijuana, the causal influence of marijuana in crashes is less certain (Deveaux and Gosset, 2000). Our results suggest that collateral use of marijuana may characterize drinkers most likely to report DUI. This relationship may be the major reason for the detection of marijuana use among arrested drivers rather than any direct effect upon crash causation.

The findings reported in this study should be interpreted in light of the study's strengths and limitations. One strength of this study is that the results are not limited to one university student population. The data are drawn from two large university campuses that were found to be very similar in the student reports of all the substance use variables studied. Another strength is that the dependent variables under study measured DUIB, DUI and RDUI during the previous 28 days. This limited period likely facilitated respondents' recall of engaging in such behavior.

This study was not, however, without limitations. First, the populations at the two universities studied are somewhat older than traditional college populations. Being large public commuter universities, each of the schools sampled have relatively high percentages of non-traditional students and students that take more than 4 years to complete their studies.

Thus, the results presented here may be of limited conceptual generalizability. Also, the dependent variable was a report of driving under the influence, a measure more salient to potential injury events than simple reports of "driving after drinking" or "within 2 h of consuming alcohol" used in other studies. However, these data were all drawn from student self-reports. Midanik (1988) did report a study that established the validity of self-reports for alcohol-related behaviors. However, one must consider that self-report data-gathering assumes that respondents can accurately report on both their own drinking behaviors and, in this case, their own marijuana use behaviors. Further, it assumes that students can accurately perceive when they are involved in drinking and driving behaviors. Although, this problem is common to studies examining correlates of drinking behavior (Wechsler et al., 1995), it is an important limitation to consider.

Acknowledgements

This study was funded by a grant from the National Institute on Alcohol Abuse and Alcoholism with support from the Center for Substance Abuse Prevention and the US Department of Education (RO1AA12540). The authors thank the anonymous reviewers for their helpful comments.

References

- Adebayo, A., 1991. Factors antecedent to impaired driving in Canadian urban sample. *Int. J. Addict.* 26, 897–909.
- Augustyn, M., Simons-Morton, B.G., 1995. Adolescent drinking and driving: etiology and interpretation. *J. Drug Educ.* 25, 41–59.
- De Gier, J.J., 2000. Review of European investigation of illicit drug prevalences in road traffic. In: Laurell, H., Schlyter, F. (Eds.), *Proceedings of the 15th International Conference on Alcohol, Drugs and Traffic Safety*, Vol. 4. ICADTS, Stockholm, Sweden, May 22–26, pp. 1143–1148.
- Deveaux, M., Gosset, D., 2000. Testing for ethanol in alternate specimens. In: Laurell, H., Schlyter, F. (Eds.), *Proceedings of the 15th International Conference on Alcohol, Drugs and Traffic Safety*, Vol. 4. ICADTS, Stockholm, Sweden, May 22–26, pp. 1037–1040.
- Gruenewald, P.J., Nephew, T., 1994. Drinking in California: theoretical and empirical analyses of alcohol consumption patterns. *Addiction* 89, 707–723.
- Gruenewald, P.J., Mitchell, P.R., Treno, A.J., 1996. Drinking and driving: drinking patterns and drinking problems. *Addiction* 91 (11), 1637–1649.
- Johnson, L.D., O'Malley, P.M., Bachman, J.G., 1998. National survey results on drug use from the Monitoring the Future Study, 1975–1997. In: *College students and young adults*, Vol. II. National Institutes of Health, Bethesda, MD.
- Klepp, K.L., Perry, C.L., Jacobs, D.R., 1991. Etiology of drinking and driving among adolescents: implications for primary prevention. *Health Educ. Q.* 18, 415–427.
- MacKinnon, D.P., Pentz, M.A., Broder, B.I., MacLean, M.G., 1994. Social influence on adolescent driving under the influence in a sample of high school students. *Alcohol, Drugs, and Driving* 10, 233–241.
- Midanik, L.T., 1988. The validity of self-reported alcohol use: a literature review and assessment. *Br. J. Addict.* 83, 1019–1030.

- National Center for Health Statistics, 1994. Current estimates from the national center interview survey, 1992. Report DHHS Publication no. (PHS) 94-1517. Public Health Service, US Department of Health and Human Services, Washington, DC.
- Presley, C.A., Meilman, P.W., Lyster, R., 1995. Alcohol on American College Campuses: Use, Consequences and Perceptions of the Campus Environment, Vol. 2. The CORE Institute Student Health Programs, Southern Illinois University at Carbondale, Carbondale, IL.
- Robbe, H.W.J., 1994. Influence of marijuana on driving. Maastricht University, The Netherlands.
- Shillington, A., Clapp, J.D., 2001. Substance use problems reported by college students: combined marijuana and alcohol use versus alcohol use. *Substance Use Misuse* 36 (5), 663–673.
- Wechsler, H., Dowdall, G.W., Davenport, A., Castillo, S., 1995. Correlates of college student binge drinking. *Am. J. Public Health* 85 (7), 921–926.
- Zador, P.L., Krawchuk, S.A., Voas, R.B., 2000. 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* 61 (3), 387–395.