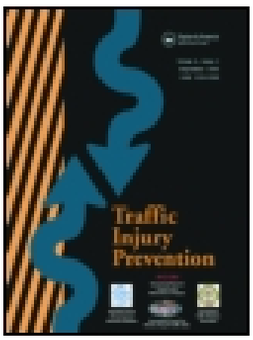

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Substance-Involved Driving: Predicting Driving after Using Alcohol, Marijuana, and Other Drugs

C. RAYMOND BINGHAM,[1] JEAN T. SHOPE,[1] and JIAN ZHU[2]

[1]University of Michigan, Transportation Research Institute, Ann Arbor, Michigan, USA
[2]University of Michigan, School of Public Health, Ann Arbor, Michigan, USA

Objectives: *Substantial research has examined the influence of alcohol, marijuana, and other illicit drugs on driving performance; however, which psychosocial characteristics of individuals who drive while under the influence of alcohol (DUIA), marijuana (DUIM), and other drugs (DUID), how these characteristics interrelate with each other, and how they differ across degrees of substance-involved driving (SID) have not been thoroughly investigated. This article identified psychosocial predictors of SID while accounting for driving behavior and the type and level of substance use and examined the associations of psychosocial characteristics and SID with citations for traffic offenses.*

Methods: *Telephone survey data and state driver history records for a sample of 5,244 young adults were analyzed using t-tests and logistic and multinomial logistic regression analysis to examine the correlates and predictors of substance-involved driving.*

Results: *Psychosocial characteristics predicted DUIA, DUIM, and DUID when tested in separate models and adjusting for driving behavior. When the substance in question was added to each model, a unique association between psychosocial characteristics and DUIA remained, but the associations between psychosocial characteristics and DUIM and DUID were completely mediated by the frequency of marijuana use and level of other drug use in their respective models. Multinomial logistic regression predicting the degree of SID, which was based on the types and combinations of SID behaviors, showed that after controlling for the use of alcohol, marijuana, and other drugs, psychosocial characteristics maintained a unique association with the degree of SID. Finally, when adjusting for driving behavior and psychosocial characteristics, the degree of SID predicted having a traffic offense.*

Conclusions: *These results indicate that reducing substance use is not the only means of targeting substance-involved driving. Interventions could have enhanced effectiveness if they also targeted individual psychosocial and behavioral characteristics, either to alter these behaviors or by tailoring the intervention or program for these characteristics.*

Keywords Young Adult; Driving; Alcohol; Drugs; Offenses

INTRODUCTION

Young adults ages 21–35 have the highest rates of driving under the influence of alcohol and are involved in more fatal alcohol-related crashes than any other age-group of drivers (National Highway Traffic Safety Administration [NHTSA], 2006). Substantial research has examined the influence of alcohol, marijuana, and other illicit drugs on driving performance; however, much less research has examined the psychosocial characteristics of individuals who drive while under the influence of alcohol (DUIA), marijuana (DUIM), or other drugs (DUID), how these characteristics interrelate, and how they differ across different degrees of substance-involved driving (SID).

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Address correspondence to C. Raymond Bingham, 2901 Baxter Road, Ann Arbor, MI 48109-2150. E-mail: rbingham@umich.edu

The rate of DUIA has declined steadily from 1982 to 2005 for all age groups of drivers, with the greatest declines observed among the youngest age groups, but alcohol continues to be the most common drug that is combined with driving, with 39% of all fatal crashes involving alcohol in 2005 (NHTSA, 2006). DUIA is followed in frequency by DUIM, and DUID is the least common of these SID behaviors. However, there are indications that the recreational use and abuse of illicit drugs are on the increase, that the rate of DUIM and DUID are increasing in frequency, as well (Albery et al., 2000), and evidence indicates that these behaviors contribute to motor vehicle crashes (MVCs; Albery et al., 2000; Furr-Holden et al., 2006; Soderstrom et al., 1996; Stoduto et al., 1993; Walsh and Mann, 1999).

Serious impairment of driving ability is known to result from alcohol, but the effects of other drugs on driving ability is less clear (Soderstrom et al., 2005). Driving after using marijuana or other illicit drugs is commonly combined with the use of alcohol, making it difficult to separate the effects of

alcohol from those of other substances on driver performance (Fergusson and Horwood, 2001; Stoduto et al., 1993; Walsh and Mann, 1999). Elevated crash rates are evident among users of marijuana and cocaine (Albery et al., 2000; Fergusson and Horwood, 2001; Macdonald et al., 2004), and the presence of delta-9-tetrahydrocannabinol (THC), the main psychoactive ingredient in marijuana and other cannabinoids, in the bloodstreams of drivers in crashes has been associated with involvement in multiple-vehicle crashes. This is distinct from alcohol, which has been more commonly associated with single-vehicle road departure crashes, higher speeds, not wearing a safety belt, and ejection from the vehicle (Longo et al., 2000; Stoduto et al., 1993). In one study, however, THC-positive crash victims brought to an emergency department were no more likely to be judged culpable of causing the MVC in question than were THC-negative patients (Soderstrom et al., 2005). In spite of the consistent association between marijuana use and involvement in MVCs, it is not clear that increased crash involvement is solely a result of impairment from THC. Fergusson and Horwood (2001) found that the association between marijuana use and increased crash involvement was no longer significant when other characteristics of the individual, such as prior DUIA, involvement in risky/illegal driving behaviors, and driver attitudes were taken into account, suggesting that increased involvement in MVCs is more a reflection of the characteristics of the drivers involved than the effects of marijuana on driver performance. However, both on-road and simulator studies have shown that THC increases reaction time, impairs time and distance judgment, reduces ability to maintain headway, increases lateral variation, and impairs sustained vigilance (Couper and Logan, 2004).

Cocaine and other stimulants are also found in the systems of drivers involved in DUID crashes. Epidemiological estimates of the presence of cocaine or its metabolites in the bloodstreams of drivers in substance-related crashes ranges from 8 to 23%, and a general population study of all crashes occurring in Wayne County, Michigan, between 1996 and 1998 found that 10% of the cases involved drivers who tested positive for cocaine. Cocaine use prior to driving is associated with increased incidence of speeding, loss of control, turning in front of oncoming vehicles, inattention, and other high-risk driving behaviors, as well as poor impulse control (Couper and Logan, 2004). Methamphetamine has a similar influence on driving ability, resulting in increased incidence of road departure crashes, speeding, and failing to stop, as well as diminished ability to divide attention, increased inattentive driving, greater impatience, and more high-risk driving (Couper and Logan, 2004).

Ecstasy (3,4-methylenedioxymethamphetamine; MDMA) is currently a highly popular club drug. On-road studies show clear evidence that driving after using MDMA results in impairment of driving ability, including a significant increase in lateral deviation, acceptance of higher levels of risk, acute changes in cognitive performance, and impaired information processing ability, but it has not been shown to be associated with reduced speed adaptation or brake reaction time (Couper and Logan, 2004; Ramaekers et al., 2006).

Research on DUIM and DUID has not widely used official state records of driving outcomes, such as traffic offenses, to examine the influence of substances on driving; however, an association between SID and a greater number of driving offenses would be consistent with the hypothesis that DUIM and DUID do sufficiently impair driving ability to result in increased offense rates. Research on SID has also not closely examined the individual psychosocial and behavioral characteristics of people who participate in this behavior. Such information could provide useful guidance for interventions, as well as greater understanding of the potential influences that promote SID.

Problem behavior theory (PBT) provides a framework for examining environmental and individual characteristics as covariates and precursors of SID. PBT classifies behavior as conventional (i.e., socially prescribed/encouraged) or problem behavior (i.e., socially proscribed/prohibited behavior) and recognizes that problem behaviors tend to co-occur within individuals, resulting in a "problem behavior syndrome." Illicit substance use and driving while under the influence of alcohol or other drugs are not typically stand-alone behaviors but, like other socially proscribed behaviors, often co-occur within individuals, forming a problem behavior syndrome. For example, individuals who drive after drinking alcohol or using other drugs often have histories of greater use of the substance (i.e., drugs or alcohol) and also have profiles of poorer psychosocial development and more tolerant attitudes toward socially deviant behaviors (Bingham and Shope, 2004a, 2004b). Past research has demonstrated that SID fits well within the framework of PBT (Donovan, 1993; Shope and Bingham, 2002).

PBT includes five systems, three of which, the perceived environment, personality, and behavior systems, were examined in this study. DUIA, DUIM, DUID, and driving behaviors were included in the behavior system. Variables in the perceived environment and personality systems provide motivation for involvement in, or avoidance of, problem behaviors, including SID (Beirness and Simpson, 1988; Donovan, 1993; Jessor, 1987; Jessor and Jessor, 1977; Jessor et al., 1997; Klepp et al., 1991; Swisher, 1988). Variables in these systems include perceptions of society, others and self, and attachment to, or alliance with, conventional social institutions (i.e., family, school, religion, the legal system, social expectations), and the values they represent (Hirschi, 1969; Jessor et al., 1983). Also included are elements of one's social and physical environment.

Although not embedded within PBT, sex has consistently been shown to moderate psychosocial characteristics and problem behaviors, including risky driving. Sex differences have been demonstrated in the associations among parental monitoring, substance use, drink/driving, and riding with a drinking driver (Copeland et al., 1996; Shope et al., 1996, 2001).

This article had four objectives. The first was to examine the extent of self-reported DUIA, DUIM, and DUID in a sample of young adults. The second objective was to identify individual psychosocial characteristics of young adults that predicted their involvement in DUIA, DUIM, and DUID, respectively, while adjusting for driving behavior and the level of the substance

in question. The third objective was to identify individual psychosocial characteristics of young adults that predicted their degree of SID while adjusting for driving behavior and substance use. Finally, the fourth objective was to determine whether the degree of SID predicted driving outcomes and to examine whether or not psychosocial characteristics and driving behavior accounted for that association. All four objectives were addressed separately for men and women.

METHODS

Sample

The study data were collected from participants in a telephone survey administered in 1999 and 2000 as part of an ongoing longitudinal study. The longitudinal study began as a follow-up of two intervention evaluation studies. Enrollment began in 5th and 6th grades with students from school districts in southeastern Michigan and continued through 12th grade in high school. Data were collected measuring demographics, substance use, perceived parental attitudes and behavior, and other psychosocial variables. Effectiveness of the interventions is reported elsewhere (Shope et al., 1992, 1998; Shope, Copeland, Maharg, et al., 1996; Shope, Copeland, Marcoux, et al., 1996).

In 1999, young adult study participants who had current Michigan driver licenses were followed up with a telephone interview. Licensure status and addresses of eligible participants were obtained from the Michigan Department of State and processed for tracking and interviewing. Advance letters invited participants to be part of the young adult follow-up and offered $10 for completing the interview and an additional $5 if they sent their telephone number to project staff by phone, e-mail, or conventional mail. The interview and study were described to the participants, and their participation constituted consent. The participants were harder to track and contact than anticipated. Once contacted, however, only 6% refused the interview. Interviews were conducted by trained personnel using computer-based interviews that allowed immediate data entry.

Respondents and non-respondents were compared on measures from State of Michigan driver history records and from the 10th and 12th grade high school surveys to check for attrition bias. There were some significant differences associated with very small effects, ranging from $d = -.009$ for alcohol availability in 12th grade to $d = .370$ for 10th grade marks in school. Only differences in age ($d = .267$; non-respondents older), 10th grade marks in school ($d = .370$, non-respondents had lower marks), and living with both biological parents at 12th grade ($d = -.203$; respondents were more likely to live with both biological parents) were large enough to be considered small effects (see Cohen, 1992). The core items of this study's analyses did not differ between respondents and non-respondents.

A by-sex age-matched comparison of the complete Michigan state driving records with those of study participants demonstrated a high degree of similarity in proportions of drivers with no offense, one offense, two or more offenses, and involvement in crashes (Elliott et al., 2000). The study participants ($n = 5244$) were 48.3% male, 88.0% white, 56.5% married, 83.0% employed, and 10.6% were students when they completed the telephone survey.

Measures

Psychosocial Characteristics.

Environment System. Tolerance of deviance was measured by 10 items (Donovan, 1993) rating the wrongness of specific behaviors. An example item is "To start a fight or hit someone." The responses ranged from 1 = very wrong to 4 = not at all wrong. An overall mean score was calculated so that higher values indicated greater tolerance of deviance ($\alpha = .79$; the measure has demonstrated construct and predictive validity).

Parent/peer influence was measured by three items that asked who the participant would go to for advice on a career decision, personal decision, and in general. Responses were 1 = parents more, 2 = parents and friends equally, and 3 = friends more. These items were averaged to obtain an overall score ($\alpha = .63$).

Personality System. Risk-taking propensity was measured by four items (Donovan, 1993). An example item is "I enjoy the thrill I get when I take risks." Responses indicating how well each item described the participant ranged from 1 = not at all like me to 3 = a lot like me. Overall scores were calculated as the mean response to the four items, with a higher score indicating a greater risk-taking propensity ($\alpha = .72$; this measure has demonstrated construct and predictive validity).

Hostility was measured by seven items (Donovan, 1993). Participants were asked to rate how well each of the items described them. An example item is "When I lose my temper I've been known to hit or slap someone." Participants indicated how well each item described them on a scale from 1 = not at all like me to 3 = a lot like me. Higher mean scores indicated greater hostility. Factor analyses show that this measure is unidimensional. The internal consistency for this measure is relatively low, $\alpha = .54$ (see Cattell, 1982); however, it has performed well as a predictor of driving behavior in past research (Bingham et al., 2007).

Driving Behaviors. High-risk driving (Donovan, 1993) was assessed by 20 items that measured frequency of exceeding the speed limit and inappropriate passing, following, lane usage, yielding/right-of-way, turning and observance of control signals. Responses were the actual frequency with which each of the behaviors occurred in the prior year and were recoded as 1 = once, 2 = twice, 3 = 3 times, 4 = 4 times, 5 = 5 times, 6 = 6–9 times, 7 = 10–14 times, 8 = 15–19 times, 9 = 20–24 times, 10 = 25–29 times, 11 = 30–49 times, 12 = 50–99 times, and 13 = 100 times or more often. Many of the behaviors measured constitute ticketable offenses ($\alpha = .86$; the measure has demonstrated construct and predictive validity; see Shope and Bingham, 2002).

Driving aggression was measured by four items asking participants how often they yell at other drivers, honk their horn at drivers who cut in, make rude gestures to other drivers, and tailgate to get back at other drivers for the way they're driving. Responses were 1 = very often, 2 = often, 3 = once in a while,

and 4 = never. The items were reverse scored and averaged so that a higher scale score indicated more driving aggression ($\alpha = .63$).

Substance Use. Alcohol quantity-frequency (QF) was measured by two items. One asked "How often do you have a drink containing alcohol?" Responses were coded 1 = never, 2 = once a month or less, 3 = 2–6 times a month, 4 = 2–3 times a week, and 5 = 4 or more times a week. The second item asked, "How many drinks do you have on a typical day when you are drinking?" Responses were 1 = 1 or 2, 2 = 3 or 4, 3 = 5 or 6, 4 = 7 to 9, and 5 = 10 or more. Non-drinkers were given the value of 0 for this measure. These two items were multiplied together and the product was used as a measure of combined quantity and frequency of drinking.

Marijuana use was measured by a single item that asked, "How often have you used marijuana in the past 12 months?" Other drug use was measured by summing across seven items that asked "Have you used (uppers, downers, tranquilizers, psychedelic drugs, cocaine/crack, heroine/other opiates, other types of drugs for non-medial reasons) in the past 12 months?" Responses were coded as 0 = no, and 1 = yes. Examples of each class of substances were provided in the interview to clarify the meaning of terms, such as "upper," "downer," "psychedelic," and "tranquilizer."

Substance-Involved Driving. DUIA was measured as the frequency of drink/driving (Donovan, 1993). The six items were, "In the past 12 months how many times did you": "drive within an hour of drinking alcohol"; "drive within an hour of drinking one or two beers or other alcoholic beverages"; "drive within an hour of drinking three or more drinks"; "drive when you felt high or light-headed from drinking"; "drive when you knew your drinking may already have affected your coordination"; and, "drink in the car while you were driving." Responses were the actual frequency with which each of the behaviors occurred in the prior year and were recoded as 1 = once, 2 = twice, 3 = 3 times, 4 = 4 times, 5 = 5 times, 6 = 6–9 times, 7 = 10–14 times, 8 = 15–19 times, 9 = 20–24 times, 10 = 25–29 times, 11 = 30–49 times, 12 = 50–99 times, and 13 = 100 times or more often (Donovan, 1993). The items were averaged to obtain scale scores. Internal consistency was good ($\alpha = .79$).

DUIM and DUID were measured by items that asked how many times in the prior 12 months the respondent driven after (1) smoking marijuana and (2) using any of the following: amphetamines, quaaludes, tranquilizers, psychedelic drugs, crack or cocaine, opiates, and prescription drugs for non-medical purposes. Responses were recoded in the same manner used for DUID (Donovan, 1993) and averaged to obtain scale scores. Internal consistency was adequate ($\alpha = .60$; see Cattell, 1982).

Degree of substance-involved driving measured participation in one or more of DUIA, DUIM, and DUID. It consisted of a four-level variable with: 1 = never involved in DUIA, DUIM, or DUID; 2 = involved in DUIA but not DUIM or DUID; 3 = involved in DUIM with or without DUIA but no DUID; and 4 = involved in DUID, with or without involvement in DUIA and/or DUIM. This ordering of substances and combinations was based on research (Kandel and Faust, 1975; Kandel and Yamaguchi, 1993) demonstrating that individuals who began using marijuana usually already used alcohol and that the initiation of other drug use was typically preceded by marijauna use. This variable was used as an ordinal measure of the degree of the participant's involvement in SID, with a higher score indicating a greater degree of SID.

Traffic Offenses. The driver history records of all participants who had a record (i.e., all Michigan licensed drivers and unlicensed individuals with a driver record resulting from an offense) were obtained from the Michigan Secretary of State's Office. A total count of all offenses issued by Michigan State Police during a 3-year interval centered on each participant's interview date was used as the indicator of traffic offenses and a comprehensive measure of driving outcomes. This variable was based on issuance of a citation and not convictions so that the measure would not be biased by plea bargaining. The citations included were not restricted to only substance-involved offenses because drug testing is inconsistently conducted, and both alcohol and other drug use can go undetected/uncited when a citation is issued for another reason.

Plan of Analysis

Descriptive statistics examined the prevalence of DUIA, DUIM, and DUID in the sample. Means, standard deviations, frequencies, and percentages were calculated separately by sex to examine variables used in this study, including involvement in DUIA, DUIM, and DUID. T-tests examined differences between men and women on the continuous measures, and relative risk estimates were calculated for dichotomous variables to compare the probability of an outcome between two groups, in this case, men and women.

Logistic regression models were estimated to address the second objective using psychosocial characteristics to predict DUIA, DUIM, and DUID separately, while adjusting for driving behavior and substance use. The two sets of psychosocial variables and driving behavior were entered in separate models, and then all together to obtain estimates of the association between the psychosocial variables and the substance-involved driving outcomes adjusted for driving behavior. This model was then further adjusted for substance use, with the model predicting DUIA being adjusted for frequency of alcohol use, DUIM for frequency of marijuana use, and DUID for the level of other drug use. The results of these models were the net associations between the psychosocial predictors and each indicator of SID when the effects of driving behavior and each substance were held constant. All models were adjusted for age of the participant.

The third objective was addressed using multinomial logistic regression models with a general logit link to predict the degree of SID. Regression models were tested in the same order as for the second objective, with the outcome being the degree of SID, rather than each substance-involved driving behavior separately. All models were adjusted for participant age.

Table I Descriptive statistics

	Men (n = 2,534)		Women (n = 2,710)		
Continuous Variables	Mean	SD	Mean	SD	P-value**
Age	24.43	0.78	24.28	0.76	<0.001
Substance use*					
Alcohol QF	4.23	3.66	2.53	2.29	<0.001
Marijuana use frequency	1.59	1.14	1.38	0.89	<0.001
Other drug use	0.18	0.66	0.10	0.45	<0.001
Psychosocial scales					
Tolerance of deviance	1.34	0.33	1.26	0.26	<0.001
Parent/peer influence	1.85	0.53	1.79	0.54	0.002
Risk-taking propensity	1.42	0.44	1.21	0.32	<0.001
Hostility	1.70	0.38	1.51	0.35	<0.001
High-risk driving	5.01	3.65	3.88	3.50	<0.001
Driving aggression	1.21	0.39	1.19	0.34	0.096
Categorical variables	Frequency	Percent	Frequency	Percent	Relative risk (95% C.I.)
One or more traffic offense (3 years)	1,300	51.30	950	35.06	1.46 (1.37, 1.56)
Driving under the influence					
Drove after using alcohol*	1,538	60.69	1,225	45.20	1.34 (1.27, 1.41)
Drove after smoking marijuana*	427	16.85	270	9.96	1.69 (1.47, 1.95)
Drove after using drugs*	116	4.58	79	2.92	1.57 (1.19, 2.08)
Degree of SID*	1	920	36.31	1,422	52.47
	2	1,152	45.46	988	36.46
	3	346	13.65	221	8.15
	4	116	4.58	79	2.92

*All substance use and substance-involved driving variables measured events in the past 12 months.
**P-values came from one-way ANOVA for continuous variables by sex.

Finally, the fourth objective was examined using logistic regression models to predict the incidence of traffic offenses using the degree of SID, psychosocial characteristics, and driving behavior, and to examine the relative contribution of the degree of SID versus psychosocial factors in predicting traffic offenses while adjusting for driving behavior. The regression models were first estimated separately for the degree of SID and for psychosocial characteristics and driving behavior. Then all of these predictors were simultaneously entered into the model to obtain mutually adjusted estimates. All of these models were adjusted for participant age.

RESULTS

Prevalence of SID

Descriptive statistics calculated for men and women address the first objective of this study and are presented in Table I. The participants in this study averaged 24 years of age. Of those participants, 2,534 were men and 2,710 were women. Substance use was consistently higher for men than women. Alcohol QF for men was 4.2 and for women was 2.5. Frequency of marijuana use was 1.6 for men and 1.4 for women, and other drug use was 0.2 and 0.1 for men and women, respectively. Considering psychosocial characteristics, men reported higher levels of tolerance of deviance, parent versus peer influence, risk-taking propensity, and hostility than women. In addition, men reported more high-risk driving than women but did not differ significantly in driving aggression. This same general pattern of sex differences also held for the number of traffic offenses, with 51.3% of men and 35.1% of women having had at least one traffic offense in the 3-year interval surrounding the survey date. For DUIA, 60.7% of men and 45.2% of women reported at least one incident in the prior year. The percentages participating in DUIM and DUID in the prior year were 16.9 and 4.6% for men and 10 and 2.9% for women. These sex differences in SID are reflected in the degree of SID as well. The largest SID group for men was group 2 (i.e., DUIA but no DUIM or DUID in the prior year), and for women it was group 1 (i.e., no SID).

Predicting DUIA, DUIM, and DUID Separately

Tables II–IV show the results of logistic regression models predicting DUIA, DUIM, and DUID separately to address the second research objective. The psychosocial measures were entered in two blocks (Model 1, environment system, and Model 2, personality system), and driving measures were entered in Model 3. Model 4 tested the effect of the psychosocial measures when adjusted for driving behavior, and Model 5 further adjusted for substance use (i.e., alcohol QF, marijuana use, or other drug use). In Models 1–3 predicting DUIA (Table II), the two pairs of psychosocial variables and driving behavior were significant for both men and women when entered in separate models. When the psychosocial predictors and driving behavior were combined in the same model (Model IV), all remained significant except driving aggression for men, whereas for women, tolerance of deviance, risk-taking propensity, and high-risk driving remained significant. When the models were further adjusted for alcohol QF (Model 5), more tolerance of deviance (odds ratio [o.r.] = 2.00), high-risk driving (o.r. = 1.12), and higher alcohol QF (o.r. = 1.52) were significant predictors of

Table II Predictors of driving under the influence of alcohol (DUIA)

Predictors	Model 1 OR (95% C.I)	Model 2 OR (95% C.I)	Model 3 OR (95% C.I)	Model 4 OR (95% C.I)	Model 5 OR (95% C.I)
Men					
Tolerance of deviance	**3.54 (2.67, 4.69)**	—	—	**2.27 (1.68, 3.07)**	**2.00 (1.43, 2.81)**
Parent/peer influence	**1.34 (1.14, 1.57)**	—	—	**1.25 (1.06, 1.48)**	1.17 (0.97, 1.41)
Risk-taking propensity	—	**1.88 (1.53, 2.32)**	—	**1.27 (1.02, 1.58)**	1.09 (0.85, 1.40)
Hostility	—	**1.84 (1.46, 2.32)**	—	**1.43 (1.12, 1.84)**	0.87 (0.65, 1.16)
High-risk driving	—	—	**1.16 (1.13, 1.19)**	**1.13 (1.10, 1.16)**	**1.12 (1.09, 1.16)**
Driving aggression	—	—	**1.36 (1.07, 1.72)**	0.97 (0.75, 1.25)	0.93 (0.70, 1.25)
Alcohol QF	—	—	—	—	**1.52 (1.46, 1.59)**
Age	0.86 (0.78, 0.96)	0.84 (0.75, 0.93)	0.86 (0.77, 0.95)	0.87 (0.78, 0.97)	0.93 (0.82, 1.05)
Women					
Tolerance of deviance	**5.54 (4.00, 7.67)**	—	—	**2.90 (2.04, 4.12)**	**2.48 (1.69, 3.64)**
Parent/peer influence	**1.19 (1.02, 1.38)**	—	—	1.10 (0.94, 1.28)	0.99 (0.84, 1.18)
Risk-taking propensity	—	**3.14 (2.41, 4.08)**	—	**1.91 (1.44, 2.52)**	**1.35 (0.98, 1.85)**
Hostility	—	**1.48 (1.18, 1.86)**	—	1.05 (0.82, 1.35)	0.86 (0.65, 1.14)
High-risk driving	—	—	**1.17 (1.15, 1.20)**	**1.14 (1.11, 1.17)**	**1.10 (1.07, 1.13)**
Driving aggression	—	—	**1.32 (1.04, 1.69)**	1.03 (0.79, 1.34)	1.23 (0.92, 1.66)
Alcohol QF	—	—	—	—	**1.79 (1.69, 1.89)**
Age	0.85 (0.77, 0.94)	0.82 (0.74, 0.90)	0.86 (0.78, 0.96)	0.88 (0.79, 0.98)	0.96 (0.85, 1.09)

Significant effects are in bold.

DUIA for men. For women, tolerance of deviance (o.r. = 2.48), risk-taking propensity (o.r. = 1.35), high-risk driving (o.r. = 1.10), and alcohol QF (o.r. = 1.79) remained significant. Age was not significant in any of the models for either men or women.

Table III presents results of the same regression models as Table II, except that DUIM was predicted, and marijuana use, rather than alcohol QF, was used to adjust the final model. The pairs of variables entered in Models 1–3 were all significant predictors of DUIM. When psychosocial variables were entered together and adjusted for driving behavior (Model 4), high-risk driving and driving aggression were no longer significant for men and driving aggression became non-significant for women. When these models were adjusted for marijuana use (Model 5), for men all of the psychosocial and driving behavior variables became non-significant, and only marijuana use remained significant (o.r. = 9.34), whereas for women high-risk driving (o.r. = 1.07) and marijuana use (o.r. = 10.28) remained significant predictors of DUIM, but the contribution of high-risk driving to the odds of DUIM was minimal.

Results of models predicting DUID are presented in Table IV. In Models 1–3 for both men and women, tolerance of deviance, risk-taking propensity, hostility, and both driving behavior measures significantly predicted DUID for both sexes. When the psychosocial variables were entered together and adjusted for driving behavior (Model 4), tolerance of deviance and risk-taking propensity remained significant predictors of DUID, as did both high-risk driving and driving aggression for men, whereas for women, tolerance of deviance risk-taking propensity and hostility remained significant. When the models were adjusted for other drug use (Model 5), only other drug use (o.r. = 6.77) and age (o.r. = 1.45) remained significant for men and only other drug use remained a significant predictor of DUIM (o.r. = 14.38) for women.

Predicting the Degree of SID

Tables V and VI display the results of the multinomial logistic regression models that predicted the degree of SID for men and women and address the third objective of this study. For men (Table V), the psychosocial variables and driving behaviors entered in Models 1–3 were all significant and distinguished among all four levels the degree of SID, with the exception of no SID and DUIA only for driving aggression. In Model 4, the psychosocial measures were entered together and adjusted for driving behavior, which resulted only in minor changes in prediction for driving aggression. In Model 5, only tolerance of deviance (no SID versus DUIA only), high-risk driving (all contrasts), and driving aggression (DUIM alone or with DUIA versus DUID with or without DUIA and DUIM) remained significant.

For women (Table VI), in Models 1–3 all of the predictors had at least one significant contrast, and most of the significance remained when the psychosocial variables were adjusted for driving behavior (Model 4), but driving aggression became non-significant for all three contrasts. In Model 5, which was adjusted for the levels of alcohol, marijuana, and other drug use, many of the effects that were significant in Model 4 dropped out, with the exception of tolerance of deviance (differences remaining between no SID and DUIM with or without DUID), parent/peer influence (difference remaining between no SID and DUID), risk-taking propensity (difference remaining between no SID and DUIM with or without DUIA), and high-risk driving (all contrasts remained significant). Age was not a significant covariate in any of the models.

Table VII displays the results of models addressing the fourth objective of this study. Two logistic regression models were estimated predicting any (1) versus no (0) citations for offenses involving moving traffic violations in the 3-year interval centered on the telephone survey date. The models, tested separately

Table III Predictors of driving under the influence of marijuana (DUIM)

Variables	Model 1 OR (95% C.I)	Model 2 OR (95% C.I)	Model 3 OR (95% C.I)	Model 4 OR (95% C.I)	Model 5 OR (95% C.I)
Men					
Tolerance of deviance	**4.66 (3.46, 6.28)**	—	—	**3.30 (2.39, 4.55)**	1.08 (0.62, 1.85)
Parent/peer influence	**1.37 (1.12, 1.68)**	—	—	**1.29 (1.05, 1.59)**	0.91 (0.65, 1.27)
Risk-taking propensity	—	**2.14 (1.69, 2.70)**	—	**1.73 (1.35, 2.22)**	1.32 (0.87, 1.99)
Hostility	—	**2.03 (1.53, 2.69)**	—	**1.48 (1.09, 2.02)**	1.37 (0.83, 2.25)
High-risk driving	—	—	**1.07 (1.04, 1.10)**	1.02 (0.99, 1.05)	1.05 (0.99, 1.10)
Driving aggression	—	—	**1.84 (1.46, 2.33)**	1.17 (0.90, 1.52)	1.48 (0.97, 2.25)
Alcohol QF	—	—	—	—	**9.34 (7.58, 11.50)**
Age	0.93 (0.81, 1.07)	0.91 (0.79, 1.04)	0.92 (0.80, 1.05)	0.94 (0.81, 1.08)	0.98 (0.78, 1.24)
Women					
Tolerance of deviance	**5.10 (3.38, 7.68)**	—	—	**2.43 (1.53, 3.86)**	1.87 (0.93, 3.75)
Parent/peer influence	**1.47 (1.16, 1.87)**	—	—	**1.38 (1.08, 1.77)**	0.98 (0.68, 1.42)
Risk-taking propensity	—	**3.22 (2.30, 4.50)**	—	**2.21 (1.55, 3.16)**	1.69 (0.97, 2.94)
Hostility	—	**3.24 (2.30, 4.58)**	—	**2.61 (1.80, 3.79)**	1.56 (0.89, 2.73)
High-risk driving	—	—	**1.14 (1.10, 1.18)**	**1.08 (1.04, 1.12)**	**1.07 (1.01, 1.13)**
Driving aggression	—	—	**1.58 (1.15, 2.16)**	0.93 (0.66, 1.33)	0.97 (0.60, 1.59)
Alcohol QF	—	—	—	—	**10.28 (8.03, 13.18)**
Age	0.93 (0.78, 1.11)	0.87 (0.73, 1.03)	0.93 (0.78, 1.10)	0.92 (0.77, 1.10)	1.09 (0.84, 1.43)

Significant effects are in bold.

by sex and adjusted for age, show slightly different patterns of prediction. In the first model (unadjusted model), only SID is entered into the model. For men, SID groups no SID and DUIA only groups did not differ significantly in their likelihood of having at least one traffic offense. However, group 3 is 1.5 times more likely than group 1 to have at least one traffic offense, and group 4 is 2.4 times more likely to have at least one traffic offense. Age was not significant in the model for men. For women, SID group 2 was 1.3 times more likely, group 3 was 2.6 times more likely, and group 4 was 2.8 times more likely than group 1 to have at least one traffic offense. Age is a significant covariate for women, with women being 1.3 times more likely to have an offense for each additional year of age.

In the second model (full model), the effects of SID group and age were adjusted for psychosocial characteristics and driving behavior variables. For both sexes the same contrast testing SID remained significant as in the unadjusted model. Hostility and high-risk driving remained significant for men, and high-risk driving and age were significant for women.

DISCUSSION

While there have been mixed results from studies examining the impact of marijuana and other drug use on driving ability and outcomes, and there are apparent differences in the manner in which different drugs affect driving ability, there is evidence that combining the use of alcohol, marijuana, and/or

Table IV Predictors of driving under the influence of other drugs (DUID)

Variables	Model 1 OR (95% C.I)	Model 2 OR (95% C.I)	Model 3 OR (95% C.I)	Model 4 OR (95% C.I)	Model 5 OR (95% C.I)
Male					
Tolerance of deviance	**6.53 (4.10, 10.41)**	—	—	**3.28 (1.96, 5.49)**	1.73 (0.84, 3.58)
Parent/peer influence	1.31 (0.91, 1.88)	—	—	1.19 (0.83, 1.73)	0.90 (0.56, 1.44)
Risk-taking propensity	—	**3.09 (2.11, 4.54)**	—	**2.35 (1.54, 3.56)**	1.71 (0.99, 2.94)
Hostility	—	**2.69 (1.65, 4.39)**	—	1.48 (0.87, 2.53)	1.29 (0.64, 2.62)
High-risk driving	—	—	**1.14 (1.08, 1.20)**	**1.07 (1.02, 1.14)**	1.03 (0.96, 1.11)
Driving aggression	—	—	**2.61 (1.89, 3.60)**	**1.68 (1.16, 2.42)**	1.61 (0.97, 2.69)
Alcohol QF	—	—	—	—	**6.77 (5.11, 8.96)**
Age	1.15 (0.90, 1.46)	1.12 (0.88, 1.42)	1.12 (0.89, 1.42)	1.15 (0.90, 1.46)	**1.45 (1.06, 1.99)**
Female					
Tolerance of deviance	**6.98 (3.69, 13.22)**	—	—	**3.80 (1.84, 7.85)**	1.56 (0.55, 4.43)
Parent/peer influence	1.29 (0.84, 1.96)	—	—	1.20 (0.79, 1.84)	0.61 (0.32, 1.18)
Risk-taking propensity	—	**2.77 (1.60, 4.80)**	—	**1.87 (1.03, 3.39)**	1.20 (0.48, 2.96)
Hostility	—	**3.02 (1.70, 5.36)**	—	**2.22 (1.19, 4.14)**	2.21 (0.91, 5.34)
High-risk driving	—	—	**1.12 (1.06, 1.19)**	1.06 (0.99, 1.13)	1.02 (0.93, 1.12)
Driving aggression	—	—	**1.70 (1.02, 2.85)**	0.96 (0.54, 1.70)	0.60 (0.26, 1.37)
Alcohol QF	—	—	—	—	**14.38 (9.47, 21.83)**
Age	1.03 (0.76, 1.40)	0.95 (0.71, 1.29)	1.01 (0.75, 1.37)	1.02 (0.75, 1.39)	1.04 (0.70, 1.53)

Significant effects are in bold.

Table V Predictors of the degree of substance-involved driving for men

SID group	Variables	Model 1 OR (95% C.I)	Model 2 OR (95% C.I)	Model 3 OR (95% C.I)	Model 4 OR (95% C.I)	Model 5 OR (95% C.I)
4 vs. 1	Tolerance of deviance	**18.43 (10.81, 31.44)**	—	—	**6.99 (3.92, 12.46)**	2.18 (0.93, 5.09)
3 vs. 1		**7.71 (5.19, 11.47)**	—	—	**4.61 (3.03, 7.02)**	1.57 (0.84, 2.92)
2 vs. 1		**3.17 (2.31, 4.34)**	—	—	**2.07 (1.48, 2.89)**	**1.89 (1.30, 2.75)**
4 vs. 1	Parent/peer influence	**1.64 (1.12, 2.39)**	—	—	1.43 (0.97, 2.12)	0.85 (0.49, 1.45)
3 vs. 1		**1.58 (1.24, 2.02)**	—	—	**1.45 (1.13, 1.86)**	1.00 (0.69, 1.44)
2 vs. 1		**1.31 (1.10, 1.56)**	—	—	**1.23 (1.03, 1.47)**	1.13 (0.93, 1.37)
4 vs. 1	Risk-taking propensity	—	**5.11 (3.36, 7.77)**	—	**2.97 (1.88, 4.67)**	1.67 (0.88, 3.15)
3 vs. 1		—	**2.59 (1.92, 3.51)**	—	**1.72 (1.25, 2.37)**	1.09 (0.68, 1.75)
2 vs. 1		—	**1.82 (1.44, 2.29)**	—	1.24 (0.98, 1.58)	1.08 (0.82, 1.42)
4 vs. 1	Hostility	—	**4.40 (2.61, 7.41)**	—	**2.07 (1.17, 3.67)**	1.45 (0.65, 3.26)
3 vs. 1		—	**2.71 (1.91, 3.84)**	—	**1.93 (1.33, 2.81)**	1.38 (0.79, 2.40)
2 vs. 1		—	**1.78 (1.38, 2.29)**	—	**1.44 (1.10, 1.89)**	0.90 (0.66, 1.23)
4 vs. 1	High-risk driving	—	—	**1.25 (1.18, 1.32)**	**1.17 (1.10, 1.24)**	**1.14 (1.05, 1.24)**
3 vs. 1		—	—	**1.14 (1.10, 1.19)**	**1.09 (1.05, 1.13)**	**1.13 (1.07, 1.20)**
2 vs. 1		—	—	**1.16 (1.13, 1.19)**	**1.13 (1.10, 1.16)**	**1.13 (1.09, 1.16)**
4 vs. 1	Driving aggression	—	—	**3.40 (2.32, 4.99)**	**1.64 (1.07, 2.51)**	**1.91 (1.04, 3.50)**
3 vs. 1		—	—	**1.85 (1.33, 2.59)**	1.01 (0.70, 1.45)	1.30 (0.79, 2.15)
2 vs. 1		—	—	1.26 (0.96, 1.67)	0.94 (0.70, 1.25)	0.93 (0.67, 1.29)
4 vs. 1	Alcohol QF	—	—	—	—	**1.40 (1.29, 1.52)**
3 vs. 1		—	—	—	—	**1.35 (1.26, 1.44)**
2 vs. 1		—	—	—	—	**1.51 (1.44, 1.58)**
4 vs. 1	Marijuana use frequency	—	—	—	—	**5.61 (4.09, 7.71)**
3 vs. 1		—	—	—	—	**9.36 (7.11, 12.32)**
2 vs. 1		—	—	—	—	1.23 (0.97, 1.56)
4 vs. 1	Other drug use	—	—	—	—	**7.59 (4.40, 13.11)**
3 vs. 1		—	—	—	—	**1.76 (1.01, 3.07)**
2 vs. 1		—	—	—	—	0.96 (0.57, 1.62)
4 vs. 1	Age	1.05 (0.82, 1.35)	0.99 (0.78, 1.28)	1.02 (0.80, 1.31)	1.05 (0.82, 1.36)	**1.56 (1.09, 2.23)**
3 vs. 1		0.87 (0.74, 1.03)	0.83 (0.71, 0.98)	0.86 (0.73, 1.01)	0.88 (0.75, 1.05)	0.99 (0.77, 1.27)
2 vs. 1		0.87 (0.78, 0.98)	0.85 (0.76, 0.95)	0.87 (0.78, 0.98)	0.89 (0.79, 0.99)	0.93 (0.82, 1.06)

Significant effects are in bold.

other drugs with driving is associated with impaired driving ability and reduced safety (Albery et al., 2000; Furr-Holden et al., 2006; Soderstrom et al., 1996; Stoduto et al., 1993; Walsh and Mann, 1999). The results of this study add to this conclusion, suggesting that substance-involved driving, whether it involves alcohol, marijuana, or other drugs alone or in combinations, was associated with a greater likelihood of having citations for driving offenses. In addition, driving after using alcohol, marijuana, or other drugs is predicted by individual psychosocial characteristics in a manner that is consistent with the theories and literature on other problem and health-compromising behaviors, even when the models were adjusted for driving behavior (Bingham et al., 2007; Bingham and Shope, 2004a, 2004b, 2005, 2006; Donovan, 1993; Shope and Bingham, 2002). While there are sex differences in the association between psychosocial characteristics, driving behavior, and substance-involved driving, these differences are limited to individual effects, with the overall conclusions arising from the results being the same for men and women.

The results of this study provided new information about the association between substance-involved driving and traffic offense involvement, showing that the likelihood of receiving a traffic offense increased significantly as the degree of substance-involved driving increased. This was true for both men and women, with the only difference being that the likelihood of an offense went up more for women than men with each increment in substance-involved driving. This is consistent with other research that has shown that while women are less likely than men to be involved in socially proscribed behaviors, such as substance-involved driving, the differences in the characteristics of those who are and are not involved in the behavior are more extreme for women than for men (Elliott et al., 2006). Hence, while a smaller proportion of women (49.1%) than men (82.1%) reported substance-involved driving, those women who were involved in it experienced a greater increase in their odds of receiving a citation for an offense than men.

This finding raises the possibility that perhaps other behavioral and psychosocial characteristics of substance-involved drivers might account for both their driving behavior and their likelihood of receiving a citation for an offense, as has been suggested by other research (Fergusson and Horwood, 2001). This possibility was tested by adjusting the models of substance-involved driving predicting offenses for the effects of driving behavior and psychosocial characteristics. While adjusting the models resulted in a decrease in the association between substance-involved driving and the likelihood of receiving an offense, it did not eliminate the effect, suggesting that the association between substance-involved driving and traffic offense

Table VI Predictors of the degree of substance-involved driving for women

SID group	Variables	Model 1 OR (95% C.I)	Model 2 OR (95% C.I)	Model 3 OR (95% C.I)	Model 4 OR (95% C.I)	Model 5 OR (95% C.I)
4 vs. 1	Tolerance of deviance	**20.60 (10.26, 41.34)**	—	—	**7.39 (3.43, 15.90)**	2.42 (0.77, 7.64)
3 vs. 1		**9.87 (5.93, 16.43)**	—	—	**3.44 (1.96, 6.03)**	**2.24 (1.02, 4.90)**
2 vs. 1		**4.91 (3.46, 6.98)**	—	—	**2.66 (1.82, 3.88)**	**2.19 (1.44, 3.31)**
4 vs. 1	Parent/peer influence	1.42 (0.93, 2.18)	—	—	1.29 (0.83, 1.99)	**0.47 (0.24, 0.94)**
3 vs. 1		**1.53 (1.17, 2.00)**	—	—	**1.39 (1.06, 1.84)**	0.90 (0.62, 1.33)
2 vs. 1		1.13 (0.97, 1.33)	—	—	1.05 (0.90, 1.24)	0.95 (0.79, 1.14)
4 vs. 1	Risk-taking propensity	—	**6.06 (3.37, 10.90)**	—	**3.15 (1.69, 5.89)**	1.55 (0.58, 4.12)
3 vs. 1		—	**5.34 (3.55, 8.03)**	—	**2.99 (1.95, 4.60)**	**1.82 (1.00, 3.33)**
2 vs. 1		—	**3.00 (2.25, 4.00)**	—	**1.86 (1.38, 2.52)**	1.33 (0.95, 1.87)
4 vs. 1	Hostility	—	**4.17 (2.30, 7.56)**	—	**2.61 (1.37, 5.00)**	1.84 (0.71, 4.73)
3 vs. 1		—	**3.69 (2.49, 5.47)**	—	**2.64 (1.72, 4.04)**	1.41 (0.79, 2.54)
2 vs. 1		—	**1.34 (1.05, 1.73)**	—	0.99 (0.76, 1.30)	0.78 (0.58, 1.06)
4 vs. 1	High-risk driving	—	—	**1.23 (1.15, 1.31)**	**1.14 (1.07, 1.23)**	**1.11 (1.00, 1.23)**
3 vs. 1		—	—	**1.23 (1.18, 1.28)**	**1.16 (1.11, 1.21)**	**1.12 (1.05, 1.19)**
2 vs. 1		—	—	**1.17 (1.14, 1.20)**	**1.14 (1.11, 1.17)**	**1.11 (1.07, 1.14)**
4 vs. 1	Driving aggression	—	—	**2.06 (1.20, 3.54)**	0.99 (0.55, 1.81)	0.82 (0.34, 1.97)
3 vs. 1		—	—	**1.73 (1.18, 2.54)**	0.97 (0.64, 1.47)	1.08 (0.62, 1.89)
2 vs. 1		—	—	1.24 (0.95, 1.61)	1.01 (0.76, 1.34)	1.19 (0.87, 1.64)
4 vs. 1	Alcohol QF	—	—	—	—	**1.45 (1.26, 1.68)**
3 vs. 1		—	—	—	—	**1.68 (1.53, 1.85)**
2 vs. 1		—	—	—	—	**1.72 (1.62, 1.83)**
4 vs. 1	Marijuana use frequency	—	—	—	—	**6.47 (4.59, 9.11)**
3 vs. 1		—	—	—	—	**9.21 (6.97, 12.18)**
2 vs. 1		—	—	—	—	**1.41 (1.12, 1.77)**
4 vs. 1	Other drug use	—	—	—	—	**21.72 (10.60, 44.47)**
3 vs. 1		—	—	—	—	**3.12 (1.56, 6.23)**
2 vs. 1		—	—	—	—	1.57 (0.86, 2.89)
4 vs. 1	Age	0.96 (0.71, 1.31)	0.86 (0.63, 1.17)	0.95 (0.70, 1.30)	0.97 (0.71, 1.32)	1.15 (0.75, 1.76)
3 vs. 1		0.85 (0.70, 1.04)	0.79 (0.65, 0.96)	0.86 (0.71, 1.05)	0.86 (0.70, 1.05)	1.06 (0.80, 1.40)
2 vs. 1		0.87 (0.78, 0.97)	0.84 (0.75, 0.94)	0.89 (0.79, 0.99)	0.90 (0.81, 1.01)	0.98 (0.86, 1.12)

Significant effects are in bold.

is primarily independent of other characteristics of the individual that have typically been found to predict problem behavior and its outcomes. This adjustment also demonstrated that individual psychosocial and behavioral characteristics have unique associations with traffic offenses that are not due to substance-involved driving.

When models predicting driving under the influence of alcohol, marijuana, and other drugs were tested separately, psychosocial characteristics and driving behavior predicted all three behaviors, but when the models were adjusted for the level of the specific substance being examined, psychosocial and driving behavior predictors remained significant only for DUIA. This suggests, as has been seen in other research (Bingham et al., 2007), that psychosocial characteristics have an association with drink/driving that is independent of the level of alcohol consumption. The results of analyses predicting DUIM and DUID

Table VII Predictors of traffic offenses

	Men		Women	
Predictors	Adjusted for age OR (95% C.I.)	Full model OR (95% C.I.)	Adjusted for age OR (95% C.I.)	Full model OR (95% C.I.)
SID group 2 vs. 1	1.14 (0.96, 1.36)	1.10 (0.91, 1.31)	**1.32 (1.12, 1.58)**	**1.23 (1.03, 1.48)**
SID group 3 vs. 1	**1.50 (1.17, 1.93)**	**1.47 (1.13, 1.91)**	**2.56 (1.92, 3.42)**	**2.26 (1.67, 3.05)**
SID group 4 vs. 1	**2.36 (1.57, 3.56)**	**2.22 (1.44, 3.42)**	**2.79 (1.76, 4.42)**	**2.45 (1.53, 3.92)**
Tolerance of deviance	—	**0.74 (0.56, 0.97)**	—	0.97 (0.69, 1.37)
Parent/peer influence	—	0.90 (0.77, 1.05)	—	1.10 (0.94, 1.28)
Risk-taking propensity	—	0.98 (0.80, 1.19)	—	1.05 (0.80, 1.37)
Hostility	—	**1.33 (1.05, 1.67)**	—	1.10 (0.86, 1.41)
High-risk driving	—	**1.03 (1.01, 1.06)**	—	**1.03 (1.01, 1.06)**
Driving aggression	—	1.06 (0.85, 1.33)	—	1.01 (0.78, 1.30)
Age	1.03 (0.93, 1.14)	1.02 (0.92, 1.13)	**1.26 (1.14, 1.40)**	**1.28 (1.15, 1.42)**

Significant effects are in bold.

suggest that this is not the case for these two behaviors but that all of the associations between psychosocial characteristics and DUIM and DUID are mediated through the use of the illegal substance in question. The difference observed in the associations between psychosocial characteristics, substance use, and substance-involved driving may be related to differences in the social proscriptions placed on marijuana and other drug use versus alcohol use. Young adults can legally drink alcohol when they are over the age of 21, but the prohibition against the illicit use of marijuana and other drugs is not age-graded, and these behaviors are illegal for everyone. Psychosocial characteristics may distinguish between drinking, which is legal, and driving after drinking, which is illegal and strongly socially proscribed. However, the results of this study suggest that this is not the case for the use of illegal substances and driving that involves those substances. The key difference is that the use of an illegal substance and driving after using it are both illegal behaviors. It is possible that the psychosocial characteristics examined in this study are not sensitive to differences in participation in two related illegal behaviors, but other variables not studied might be sensitive to that difference. It is also possible that the reason the predictors used in this study did not distinguish between illicit drug use and driving after using the illicit substances examined was because the association between these two behaviors is different from that between drinking alcohol and driving after drinking alcohol. For example, conditions that lead a person who uses an illicit substance to drive after using it may not be systematic but associated more with current circumstances or opportunity, while DUIA may be a more systematic and habitual behavior related to the perceived need to drive after drinking or patterns of social interaction (e.g., going to the bar after work and then driving home). Further research is needed to test these hypotheses and gain greater understanding of the underlying processes involved.

When substance-involved driving was examined slightly differently to address the second study objective, using a variable that accounted for driving after using one or more substances, different results were observed. In these models, for both men and women, the associations between psychosocial and behavioral characteristics and the degree of substance-involved driving remained significant when alcohol, marijuana, and other drug use were included. This suggests that psychosocial and behavioral characteristics do have a unique association with impaired driving that varies in degree depending on which drugs are used and in what combinations.

These results have implications for interventions, programs, and policies intended to reduce substance-involved driving. They indicate that reducing substance use is not the only means of targeting substance-involved driving but interventions that also target psychosocial and behavioral characteristics, either to alter these behaviors or by tailoring the intervention or program for these characteristics, could contribute to enhanced effectiveness. For example, past research on this sample has indicated that parental monitoring and permissiveness of the participants as adolescents has long-lasting associations with problem behavior involvement, including substance-involved driving and traffic offense and crash incidence (Bingham, Shope, 2004a, 2004b, 2005, 2006). In other research, multiple evaluations of the Checkpoints Program have demonstrated its effectiveness in reducing teen driver risk by increasing parental supervision of teenaged drivers (Simons-Morton et al., 2004, 2005, 2006). Together, these studies suggest that interventions that increase parental monitoring and limit setting with their teens could have long lasting influences on driving-related risk behaviors and driving outcomes, including substance-involved driving. Nevertheless, while the results of this study provide additional information and understanding of the associations between psychosocial characteristics and problem driving behavior, its implications for interventions and programs are limited to individual and behavioral characteristics related to constellations of problem behavior. What would be of much greater value would be a more extensive understanding of the etiology of problem behavior development and how problem behavior involvement progresses from minor problem behaviors to include highly serious and potentially injurious problem driving behaviors. Information on problem behavior etiology could identify key points in the development of substance-involved driving when specific interventions might be strategically applied to much greater effect than is possible without such knowledge. Additionally, an understanding of the etiology of substance-involved driving also holds the potential of revealing modifiable variables that have not previously been the target of behavior change interventions, programs, and policies.

In spite of its contributions and strengths, the current study was limited by its cross-sectional nature, which made it impossible to identify chains of associations over time that lead to substance-involved driving. As just mentioned, one way forward for the field is to use longitudinal data to examine such associations to gain more information about the development of substance-involved driving. The sample examined in this study was not drawn to be representative; however, this limitation is reduced to some degree by analyses demonstrating that the driving behavior of individuals in this sample is highly similar to that of other Michigan drivers of the same age and sex. Those analyses showed no differences, suggesting that in terms of driving performance, this sample is not unique. Finally, this study relied on a finite set of measures that, while tapping interesting and important domains, were not comprehensive. Future research should build on the evidence provided here of associations between psychosocial characteristics and driving outcomes by examining additional measures of these and other conceptual domains so that the nature of substance-involved driving and the characteristics of substance-involved drivers can be more broadly understood.

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