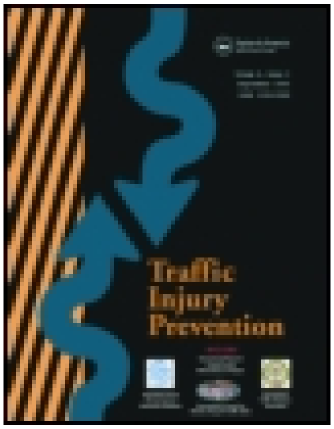

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Self-Reported Collision Risk Associated With Cannabis Use and Driving After Cannabis Use Among Ontario Adults

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Objective: *This study examined the effects of cannabis use and driving after cannabis use on self-reported collision involvement within the previous 12 months while controlling for demographics, driving exposure, binge drinking, and driving after drinking based on a large representative sample of adults in Ontario.*

Methods: *Data are based on the CAMH Monitor, an ongoing cross-sectional telephone survey of Ontario adults aged 18 and older, conducted by the Centre for Addiction and Mental Health. Data on drivers who reported driving at least one kilometer per week and who responded to the collision item from 2002 to 2007 were merged into one data set (n = 8481). Logistic regression analysis of self-reported collision risk posed by cannabis use (lifetime and past 12 months), driving after cannabis use (past 12 months), and driving after drinking among drinkers (past 12 months) was implemented, controlling for the effects of gender, age, region, income, education, marital status, kilometers driven in a typical week, and consuming five or more drinks of alcohol on one occasion (past 12 months). Due to list-wise deletion of cases the logistic regression sample was reduced (n = 6907).*

Results: *Several demographic factors were found to be significantly associated with self-reported collision involvement. The logistic regression model revealed that age, region, income, marital status, and number of kilometers driven in a typical week, were all significantly related to collision involvement, after adjusting for other factors. Respondents who reported having driven after cannabis use within the past 12 months had increased risk of collision involvement (odds ratio [OR] = 1.84) compared to those who never drove after using cannabis, a greater risk than that associated with having reported driving after drinking within the past 12 months (OR = 1.34).*

Conclusion: *Further investigation of the impact of driving after cannabis use on collision risk and factors that may modify that relationship is warranted.*

Keywords Collisions; Cannabis use; Driving after cannabis use; Drinking-driving; Population survey

INTRODUCTION

Driving under the influence of cannabis (DUIC) seems to be relatively uncommon in the general population (Walsh and Mann 1999) but may be frequent among heavy users of cannabis (Macdonald et al. 2004) and young people (Adlaf et al. 2003; Asbridge et al. 2005; Fischer et al. 2006). The impact of DUIC on collision risk has been unclear. After alcohol, cannabis is the psychoactive drug most often found in seriously and fatally injured drivers (Dussault et al. 2002; Stoduto et al. 1993). Additionally, laboratory studies demonstrate that cannabis impairs a variety of skills involved in the driving task (Ashton 2001; Beirness et al. 2006; Kalant 2004; Kelly et al. 2004; Mann et al. 2008; Moskowitz 1985; Ramaekers et al. 2006).

Epidemiological studies on the effects of cannabis on collision risk have provided mixed results. Some studies have found an increase in collision risk associated with the use of cannabis (e.g., Chipman et al. 2003; Drummer et al. 2004; Dussault et al. 2002; Laumon et al. 2005). Other studies have found no significant increase in collision risk associated with DUIC (e.g., Blows et al. 2005; Longo et al. 2000a, 2000b), whereas still others have reported a protective effect of cannabis use on driving, citing compensatory behaviors in response to perceived impairment as a possible cause (e.g., Drummer 1995; Gmel et al. 2009; Sewell et al. 2009). Studies of the effects of cannabis on collision risk typically employ some variant of the case-control design that

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has been valuable in understanding the impact of alcohol on collision risk (e.g., Borkenstein et al. 1964). A key challenge in using this design to evaluate the effects of cannabis on collision risk is that the presence of cannabis in the body is much more difficult to measure than alcohol. Measurement of cannabinoids in blood samples is the preferred method, but these samples are very difficult to obtain, particularly from control groups. Some studies have used urine samples to assess the presence of cannabis. However, cannabinoids may be found in urine for several days following use, and thus the presence of cannabis in urine at the time of a collision may not reflect any behavioral impact of the drug on driving ability (Mann et al. 2003). Other studies have used responsibility analysis procedures (e.g., Longo et al. 2000a, 2000b). Responsibility analysis is based on post hoc assignment of culpability based on police reports of collision characteristics (e.g., Terhune 1983). Responsibility analysis may underestimate collision risks associated with cannabis (Terhune 1983), in part because police assessments of culpability and descriptions of collisions on which these decisions are made may lack sensitivity and reliability (Shinar et al. 1983). Several authors have noted that the evidence on the contribution of cannabis use to collision risk is inconclusive and more research on this topic is needed (Beirness et al. 2006; Moskowitz 2006).

Convergent evidence from other types of studies on the impact of cannabis use and DUIC on collision risk would provide very important information on the role of cannabis in collision involvement (e.g., Richer and Bergeron 2009). One such method involves measuring collision risks associated with DUIC using survey data. Recent studies have examined the impact of self-reported cannabis use and DUIC on self-reported collision risk in a Canadian survey data of adults (Mann et al. 2007) and adolescents (Asbridge et al. 2005). Both studies observed a significant increase in self-reported collision risk in the past year associated with DUIC. Among adult drivers in Ontario, self-reported cannabis use, cannabis problems, and DUIC were associated with about twice the likelihood of reporting a collision in the past 12 months (Mann et al. 2007). Though a relationship of DUIC with increased collision risk was observed, the finding that cannabis use also was related to increased collision risk could support an explanation based on underlying personality factors such as increased risk-taking propensity (Mann et al. 2007; Richer and Bergeron 2009). Similarly, the effects of drinking-driving on collision risk were not controlled in this study. DUIC and drinking-driving are strongly related, with drivers likely to report DUIC also being likely to report drinking-driving (Macdonald et al. 2004; Walsh and Mann 1999). Cannabinoids and alcohol are frequently found together in deceased and injured drivers (e.g., Stoduto et al. 1993), and several responsibility studies have cited the combination of cannabinoids and alcohol as having worse driving-related consequences than cannabis use alone (see Sewell et al. 2009). Thus, any apparent increase in collision risk due to cannabis use may be due instead to the collision-increasing effects of alcohol (Mann et al. 2001). In their study of high school students, Asbridge et al. (2005) observed that students who reported DUIC had odds of collision involvement twice as high as students who did not report DUIC, even after controlling for driving after drinking. However, the impact of DUIC on collision risk among adolescents could be different than that among adults for several reasons, including increased propensity for risk-taking among young people (Mann et al. 2007).

We report here an evaluation of the impact of DUIC on self-reported collision risk in a representative sample of the Ontario adult population. The association between DUIC and collision risk in the adult population noted in previous research (Mann et al. 2007) could be due to the failure to control for the effect of driving after drinking and also for the effects of driving exposure and risk-taking propensity in general. In this study we control statistically for the effects of driving after drinking and driving exposure. We also include measures reflecting risk-taking propensity, specifically binge drinking (drinking five or more drinks on at least one occasion in the past year) and use of cannabis. Previous studies suggest that people who show elevated risk-taking propensities are more likely to report either or both of these behaviors (e.g., Donovan and Jessor 1985; Jonah 1997). For example, binge drinking has been shown to be associated with sensation seeking and impulsivity, both strong personality predictors of risk-taking behavior (Andrew and Cronin 1997; Balodis et al. 2009). By including binge drinking, cannabis use, and drinking-driving, it is possible to control for behaviorally relevant risk-taking propensity when assessing the association between DUIC and collision risk.

METHOD

Sample

The data for this investigation were drawn from the CAMH Monitor, a repeated cross-sectional telephone survey of Ontario adults (18 years or older) conducted by the Centre for Addiction and Mental Health and administered by the Institute for Social Research at York University. First conducted in 1996, the CAMH Monitor is designed to serve as the primary vehicle for monitoring addiction and mental health issues in Ontario. Since December 2002, the CAMH Monitor survey has included a self-report collision item and a driving exposure measure. For the purposes of the current study, data on drivers who reported driving at least one kilometer per week and who responded to the collision item from 2002 to 2007 were merged into one data set ($N = 8481$). The survey uses random-digit-dialing methods via the Computer Assisted Telephone Interview. The interview length is an average of 25 minutes. The CAMH Monitor each year consists of 12 independent monthly surveys with 200 completions expected each month. The design employs a two-stage probability selection procedure. Each month a sampling frame of all active area codes and exchanges in Ontario is provided by the ATT Long Lines Tape. Within each regional stratum, a random sample of telephone numbers is selected with equal probability in the first stage of selection (i.e., households).

Within selected households, one respondent aged 18 or older who can complete the interview in English or French is selected according to the most recent birthday of household members. Across years, response rates have ranged from 53 to 61 percent. To increase the precision of estimates within different areas of the province, the sample is equally allocated among six strata according to area code and the corresponding counties. Because the sample is allocated equally within each of the six regions, weights that are a function of the sampling weight and the poststratification adjustment are required to restore population representation. Calculation of the 12-month aggregated sampling weight variable consists of three elements: household, region, and survey wave (month of sampling). Within each wave and region, relative household weight is directly proportional to the number of household residents age 18 and older. Within each cycle, relative region weight is directly proportional to the percentage of all Ontario households located in the region. Census data for Ontario for each year included in the sample are used for post-strata population adjustments based on age (18–24, 25–44, 45–64, 65+) and gender configuration. For additional details regarding sampling design see Ialomiteanu and Adlaf (2008).

Dependent Variable

The key outcome measure was collision involvement: "During the past 12 months, how often, if at all, were you involved in an accident or collision involving any kind of damage or injury to you or another person or vehicle while you were driving?" (recoded yes = 1, no = 0).

Independent Variables

Demographic variables included gender (coded 1 = male, 0 = female), age (continuous) and age categories (coded 1 = 18–34, 2 = 35–54, 3 = 55 and older), region (comprised of six regions in Ontario: Toronto, Central East, Central West, West, East, North), income (<$30,000, $30,000–49,000, $50,000–79,000, $80,000+, not stated), education (<high school, completed high school, some postsecondary, university degree), and marital status (married/partner, previously married, never married).

Driving exposure was assessed by a question on how much they drive in a typical week (number of kilometers, continuous variable, range 1–8000).

Binge drinking was measured with a single item: "About how often during the past 12 months would you say you had five or more drinks at the same sitting or occasion?" (coded never = 0, at least once = 1). In the introduction to questions concerning alcohol consumption, the word *drink* was defined as one 12-ounce bottle of beer or glass of draft, one 5-ounce glass of wine, or one straight or mixed drink with one and a half ounces of hard liquor.

Cannabis use was assessed by two items: "Have you ever in your lifetime used marijuana or hash?" and "How many times, if any, have you used marijuana or hash during the past twelve months?" (recoded yes = 1, no = 0).

Driving after cannabis use was assessed by asking, "During the past 12 months, have you driven a motor vehicle within an hour of using marijuana or hash?" (coded yes = 1, no = 0).

Driving after drinking was measured by a single item: "During the past 12 months, have you driven a motor vehicle after having two or more drinks in the previous hour?" (Reported among respondents who had consumed alcohol at least once in the past 12 months, coded yes = 1, no = 0).

Analyses

The results in this article are based on "valid" responses (n's) such that missing data (i.e., "Don't know" responses and refusals) were excluded from analyses. SPSS 15.0 software was employed for all analyses. The percentages reported are based on the weighted sample size and are considered representative for the population surveyed. Data on prevalence of collision involvement by independent variables were examined through chi-square and t-test analyses.

Logistic regression analysis was conducted to assess the impact on collision risk of cannabis use, driving after using cannabis, and driving after drinking, controlling for demographic measures, driving exposure, and binge drinking. Due to list-wise deletion of cases, the sample ($n = 6907$) includes drivers who drove at least 1 kilometer per week and who reported consuming at least one drink in the past year.

RESULTS

A total of 584 (7.6%) respondents reported having been involved in a collision involving any kind of damage or injury while driving during the past 12 months; 6.9 percent had one collision, 0.6 percent had 2 collisions, and 0.1 percent reported more than 2 collisions. Table I presents data on self-reported collision involvement by our control measures: demographic, driving exposure, and binge drinking measures. There were significant differences in collision involvement by gender ($X^2_{(1df)} = 4.5$, $p < .05$), age group ($X^2_{(2df)} = 65.8$, $p < .001$), region ($X^2_{(5df)} = 20.1$, $p = .001$), income ($X^2_{(4df)} = 28.8$, $p < .001$), education ($X^2_{(3df)} = 8.4$, $p < .05$), and marital status ($X^2_{(2df)} = 64.7$, $p < .001$). The prevalence of self-reported collision involvement was highest for younger drivers (18- to 34-year olds, 11.3%) and lowest for the oldest group (5.8%). Almost one tenth of those with incomes $80,000 or more (9.1%) reported a collision in comparison with 4.6 percent of those who did not state an income. Respondents who had not completed high school reported the lowest collision prevalence (5.3%), as well as respondents who were married or living with a common-law partner (6.3%). Self-reported collision involvement was more common among those who lived in the Toronto region (9.8%), whereas those who lived in the north reported the lowest prevalence of collision involvement (5.7%). Respondents who reported collision involvement drove a significantly greater number of kilometers in a typical week compared to those who had not reported a collision ($t = -2.55$, $df = 748$, $p < .05$). We also found significant increases in collision involvement for

Table I Self-reported collision involvement by sample characteristics: Ontario CAMH Monitor, 2002–2007

Total	Sample N	Collision involvement[a] Yes (%)
	8481	7.6
Gender*		
Male	4120	8.2
Female	4361	7.0
Age***		
18–34	1896	11.3
35–54	3821	6.3
55+	2622	5.8
Region***		
Toronto	1101	9.8
Central east	1407	7.1
Central west	1453	8.1
West	1511	6.2
East	1434	7.5
North	1575	5.7
Income[b]***		
<$30,000	1042	7.6
$30,000–49,999	1404	6.9
$50,000–79,999	1984	7.6
$80,000+	2760	9.1
Not stated	1290	4.6
Education*		
<High school	1000	5.3
Completed high school	1996	8.3
Some postsecondary	2972	8.0
University degree	2432	7.5
Marital status***		
Married/common-law partner	5512	6.3
Previously married	1456	8.0
Never married	1453	12.2
Kilometers driven typical week[c]*		Yes vs. No
mean (SD)		376.3 (562.5) vs. 318.2 (516.2)
Five+ drinks last 12 months***		
Never	4678	6.6
At least once	3774	8.8

[a]At least once in the last 12 months.
[b]Canadian dollars.
[c]Among drivers who drove at least 1 km per week.
Statistical significance $*p < .05$, $**p < .01$, $***p < .001$.

those who reported consuming 5 or more drinks on a drinking occasion at least once in the past year ($X^2_{(1df)} = 13.9$, $p < .001$).

Table II presents data on self-reported collision involvement by measures of cannabis use, cannabis and driving, and drinking-driving (among past year drinkers). A total of 3493, or 41.2 percent, of adult drivers reported having used cannabis in their lifetime. A significantly higher prevalence of collision involvement was found for those who had consumed cannabis in their lifetime (9.3%) compared to only 6.4 percent of those who never used cannabis ($X^2_{(1df)} = 24.0$, $p < .001$). Similar results were found for cannabis use in the last 12 months ($X^2_{(1df)} = 52.8$, $p < .001$).

A total of 192 drivers (2.9%) reported having driven a motor vehicle within an hour of using cannabis during the past year; prevalence of self-reported collision involvement was significantly higher among those who drove after using cannabis (20.2%) compared to those who did not drive after using cannabis (7.2%; $X^2_{(1df)} = 58.1$, $p < .001$). A total of 631 drivers (9.2%) reported having driven a motor vehicle after having two or more drinks in the previous hour during the past year. As expected prevalence of self-reported collision involvement was significantly higher among those who drove after drinking in the last 12 months (12.0%) compared to those who did not (7.6%; $X^2_{(1df)} = 16.3$, $p < .001$).

Table II Self-reported collision involvement by cannabis use, driving after cannabis use, and drinking-driving: Ontario CAMH Monitor, 2002–2007

	Sample N	Collision involvement[a] Yes (%)
Cannabis use—lifetime***		
No	4925	6.4
Yes	3493	9.3
Cannabis use—last 12 months***		
No	7527	6.8
Yes	927	13.2
Driving after cannabis use—last 12 months***		
No	8261	7.2
Yes	192	20.2
Driving after drinking—last 12 months[b]***		
No	6559	7.6
Yes	631	12.0

[a]At least once in the last 12 months.
[b]Among past year drinkers.
Statistical significance $*p < .05$, $**p < .01$, $***p < .001$.

We found that reporting driving after cannabis use within the last 12 months was more common among those who reported driving after drinking ($X^2_{(1df)} = 204.6$, $p < .001$). Among drinking drivers, 12.5 percent reported driving after cannabis use. Among all drivers, 8.1 percent reported driving after drinking but did not drive after cannabis use, 2.1 percent drove after cannabis use but did not drive after drinking, and 1.2 percent reported both driving after cannabis use and driving after drinking in the previous year.

Table III presents the logistic regression model of self-reported collision risk, controlling for demographic characteristics, driving exposure, binge drinking, and drinking-driving. Age (odds ratio [OR] = 0.989, confidence interval [CI] 0.981, 0.997), region overall (specifically the north [OR = 0.53, CI 0.35, 0.81] west [OR = 0.56, CI 0.41, 0.78] and central east [OR = 0.67, CI 0.51, 0.88] regions) relative to Toronto, income overall (specifically those respondents not stating an income [OR = 0.56, CI 0.36, 0.87] relative to those earning less than $30,000), marital status overall (specifically respondents who reported never being married [OR = 1.54, CI 1.20, 1.96] or being previously married [OR = 1.41, CI 1.03,1.92] relative to married/common-law respondents), and number of kilometers driven in a typical week were all significant predictors of

Table III Logistic regression model predicting self-reported collision involvement risk: Ontario CAMH Monitor, 2002–2007 ($N = 6907$)

	Collision involvement[a]	
	OR	95% CI
Control variables:		
Gender (ref. = female)	.98	.82, 1.19
Age	.989**	.981, .997
Region (ref. = Toronto)	**	
Central east	.67**	.51, .88
Central west	.81	.63, 1.05
West	.56***	.41, .78
East	.80	.59, 1.08
North	.53**	.35, .81
Income[b] (ref. =<$30,000)	**	
$30,000–49,999	.78	.53, 1.16
$50,000–79,999	.93	.65, 1.33
$80,000+	1.10	.78, 1.56
Not stated	.56**	.36, .87
Education (ref. =<high school)		
Completed high school	1.39	.92, 2.10
Some postsecondary	1.30	.86, 1.94
University degree	1.24	.82, 1.87
Marital status (ref. = married/common-law)	***	
Previously married	1.41*	1.03, 1.92
Never married	1.54***	1.20, 1.96
Km driven typical week[c]	1.00*	1.000, 1.000
Five+ drinks (ref. = never)	.94	.78, 1.15
Risk factor variables:		
Cannabis use—lifetime (ref. = no)	1.00	.81, 1.23
Cannabis use—last 12 months (ref. = no)	1.16	.87, 1.55
Driving after cannabis use (ref. = no)	1.84**	1.23, 2.76
Driving after drinking[d] (ref. = no)	1.34*	1.02, 1.76
Constant	.12***	
Hosmer and Lemeshow test (2000)	13.48 $df = 8$ $p = .096$	

[a]At least once in the last 12 months.
[b]Canadian dollars.
[c]Among drivers who drove at least 1 km per week.
[d]Among past year drinkers.
ref. = reference category.
OR = Odds ratio.
95% CI = 95% confidence interval.
Wald statistical significance $*p < .05$, $**p < .01$, $***p < .001$.

self-reported collision involvement. Focusing on the risk factor variables, the logistic regression model revealed that driving after cannabis use was significantly associated with collision risk; those who reported driving after cannabis use had an increased risk of collision involvement (OR = 1.84, CI 1.23, 2.76) compared to those who never drove after using cannabis. Also, reporting driving after drinking significantly increased the odds of collision involvement (OR = 1.34, CI 1.02, 1.76). Interestingly, measures of cannabis use by itself did not significantly affect collision risk.

DISCUSSION

The impact of DUIC on collision risk has been an area of controversy. This is due in part to the difficulties in conducting case-control studies of the effects of cannabis use on collision risk, and thus convergent evidence from other research approaches provides valuable evidence to this question. Survey research can provide convergent evidence of the potential effect of DUIC on collision risk and has the additional benefit of permitting measurement of psychological and behavioral factors that may underlie any relationship observed.

In this study we assessed the relationship between self-reported DUIC and collision risk in survey data obtained from a representative sample of Ontario adults. Though these data are of interest, several limitations must be kept in mind. First, the data are based on self-report and thus may be affected by recall bias. However, reviews of self-report methods for alcohol and drug use suggest that although surveys tend to underestimate true usage, they are still regarded as the best means to estimate such behaviors for public health purposes (Harrison et al. 1993; Turner et al. 1992). Second, the group reporting driving after cannabis use is relatively small. Third, the frequency of cannabis and alcohol use or driving after use is not considered. The dichotomous treatment of substance use may serve to moderate the estimates of its association with collision risk. Fourth, although the response rate for the survey is considered good for surveys of this nature (Aday 1996), we cannot be certain that nonrespondents would have responded the same way as respondents in this study. However, because other research has demonstrated that nonrespondents in studies of substance use and driving behavior are likely to be heavier substance users (Mann et al. 2002), it seems probable that any bias introduced by nonresponse would be a conservative one. A related issue here is that the survey relies on sampling households with traditional landline telephones. Statistics Canada (2008) estimated that in 2007, 6.4 percent of households reported having cell phones only. Not including cell phone–only households may influence the representativeness of the sample. In particular, younger individuals may be more likely to have cell phones only and thus may be underrepresented in the sample reported here. Because younger individuals are more likely to drive after using cannabis, this would tend to reduce the overall numbers and rates of cannabis-related collisions and thus could exert a conservative bias on the results. Finally, we cannot determine from the present data whether any of the collisions reported by those who drove after cannabis use actually involved cannabis use and driving.

Keeping these limitations in mind, the results are of substantial interest. We observed that drivers who reported DUIC were significantly more likely to report a collision in the previous year than those who did not. This relationship remained significant after controlling for demographic factors, driving exposure, cannabis use, binge drinking, and driving after drinking. Thus, these results confirm and extend previous observations on the impact of DUIC on collision risk in surveys of adults and adolescents (Asbridge et al. 2005; Mann et al. 2007).

One possible explanation of the link between DUIC and collision risk, based on the observed strong relationship between DUIC and drinking-driving, is that DUIC-related collisions may instead be due to alcohol (Cimbura et al. 1990; Drummer 1995; Seymour and Oliver 1999; Stoduto et al. 1993). It seems very likely that this is the case, in at least some instances. Studies of drivers injured or fatally injured in collisions often find alcohol and cannabis together (e.g., Stoduto et al. 1993). Although it is not possible to separate out the relative contributions of alcohol and cannabis to individual collisions, the effects of alcohol are well known and widely agreed on in the scientific literature (Borkenstein et al. 1964; Mann et al. 2001) in comparison to the effects of cannabis (Beirness et al. 2006; Moskowitz 1985; Vingilis and Macdonald 2002). Recent studies are able to provide some evidence of the combined effects of cannabis and alcohol, suggesting that collision risk is increased by the combined use of these substances (see Sewell et al. 2009). Although some studies have failed to find an effect of cannabis use alone on collision risk (Bates and Blakely 1999; Sewell et al. 2009; Terhune et al. 1992; Williams et al. 1985) or have noted a protective effect of cannabis use (Drummer 1995; Gmel et al. 2009; Sewell et al. 2009), other researchers have found that cannabis by itself is associated with elevated collision risk (Dussault et al. 2002; Laumon et al. 2005). Our results confirm this latter observation. We observed that both DUIC and drinking-driving were associated with elevated likelihood of reporting a collision in the past year. Thus, this evidence would support the interpretation that any elevated collision risk seen with cannabis is not simply due to the common co-occurrence of DUIC with drinking-driving but instead reflects an association of DUIC itself with elevated collision risk. This is supported by the finding that the risk of collision involvement associated with driving after cannabis use was greater (OR = 1.84) compared to the risk associated with driving after drinking (OR = 1.34).

Cannabis use and presumably DUIC are associated with behavioral and personality traits related to risk-taking, as is collision involvement (e.g., Donovan and Jessor 1985; Jonah 1997). Thus, an observation of an association of DUIC with collision risk could be due to a common underlying factor like risk-taking (Mann et al. 2007; Richer and Bergeron 2009). In this study we did not have a direct measure of risk-taking available for use as a covariate, but we were able to include binge drinking and cannabis use, which are both known to be related to risk-taking propensity (Andrew and Cronin 1997; Balodis et al. 2009; Donovan and Jessor 1985; Jonah 1997). Even when these measures were included, DUIC remained significantly associated with collision risk. Interestingly, neither of these measures was a significant predictor of collision risk when other variables were controlled for. However, we also included driving after drinking in these analyses, and this measure was significantly related to collision risk. This measure also may reflect risk-taking propensity, and thus risk-taking propensities may be reflected in the results through self-reported driving after drinking. Thus, these results may suggest that our previous observation of an increase in collision risk associated with cannabis use and cannabis problems may have reflected risk-taking propensities, rather than some form of relationship between cannabis use specifically and collision risk (other than what may be accounted for by DUIC). Thus, these observations suggest that the behavior of driving after using cannabis, but not simply using cannabis, increases collision risk. Nevertheless, the limitations of the risk-taking proxy measures used here suggest that additional research using other measures of risk-taking would be useful.

As noted above, an important limitation of this work is that the outcome of interest, self-reported collision involvement, is very broad. We cannot determine which, if any, of the collisions reported actually involved cannabis use. Other personal and environmental factors not studied here (e.g., speeding, driver errors, weather conditions) could account for some of the collisions; however, we cannot say whether these factors differentially affect respondents who report cannabis and driving. Replication of this work with a more specific question reflecting collisions experienced while under the influence of cannabis would be valuable.

This and other recent studies (Asbridge et al. 2005; Mann et al. 2007), taken together, point to the value of survey data in assessing the impact of cannabis (and other substances) on collision risk. Epidemiological studies of the impact of cannabis use on collision risk using case-control or similar methodologies (e.g., Drummer et al. 2004; Laumon et al. 2005) are necessary but are also very difficult and costly to undertake. Information from these studies can profitably be supplemented by data from other sources, such as the survey data employed here. Measures of potential interest, such as frequency of substance use or dependence symptoms, as well as many other demographic and personality measures that could affect the relationship between cannabis use and collision risk can be collected much more readily in survey studies.

As noted earlier, these data cannot be assumed to reflect causal influence. Nevertheless, they are consistent with other recent studies suggesting an important link between DUIC and collision risk. In view of the apparent high prevalence of DUIC among younger drivers (Adlaf et al. 2003; Asbridge et al. 2005; Fischer et al. 2006) who are at increased risk for collision involvement, further investigation of the impact of DUIC on collision risk, and of factors that may modify that relationship, is warranted.

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